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Contextual and psychological factors shaping evaluations and acceptability of energy alternatives: Integrated review and research agenda

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ABSTRACT

Sustainable energy transitions will be hampered without sufficient public support. Hence, it is important to understand what drives public acceptability of (sustainable) energy alternatives. Evaluations of specific costs, including risks, and benefits of different energy alternatives have been linked to acceptability of these alternatives. But how do people come up with these evaluations, and which evaluations are the key drivers of acceptability? In this review, we propose a comprehensive conceptual framework in which we integrate two growing but so far unconnected bodies of research on how objective characteristics of energy alternatives (i.e., contextual factors), on one hand, and, on the other hand, general psychological factors shape evaluations and acceptability of energy alternatives. Importantly, we identify general factors, particularly values, that may influence evaluations and acceptability of many different energy alternatives on a general as well as community level. We put forward a research agenda with two major themes. First, we lay out possibilities to strengthen the current knowledge basis for a conceptual framework that explains evaluations and acceptability of energy alternatives. Second, we suggest how the framework could be extended to explain evaluations and acceptability of energy alternatives in a more comprehensive and accurate way. Based on the knowledge developed, we discuss policy implications, some of which have not been put forward yet and hence propose new possibilities for interventions aimed at enhancing sustainable energy transitions.

Contents

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1. Introduction

Public acceptability is becoming a major issue in the energy domain, especially in relation to sustainable energy transitions. Different types of energy sources have been promoted as (relatively) sustainable. For example, energy generated from renewable resources such as wind, solar, and hydrogen; nuclear energy; and energy generated from specific types of fossil fuels that are argued to emit less CO_2, such as natural gas. We refer to these energy sources and their surrounding contexts, including the infrastructure, technology, regulations and policies, as *energy alternatives*. Any (sustainable) energy alternative will grind to a halt without sufficient public support, and hence it is important to understand how public acceptability develops, and how it can change to enhance sustainable energy transitions. We define acceptability of energy alternatives as a general evaluation, that is, the extent to which people (dis)favour a particular energy alternative. Acceptability of energy alternatives can be reflected in people's opinions as well as their (intended) actions towards these alternatives. We focus on *general public acceptability*, which refers to overall support for different energy alternatives, as well as *community acceptability*, which refers to acceptability of energy alternatives that are (to be) hosted within a certain community [1].[1] Our aim is to identify common factors that influence evaluations and acceptability of many different energy alternatives on a general and community level and hence are key targets for energy policies. On the basis of this, we propose a comprehensive conceptual framework that integrates key factors influencing evaluations and acceptability of energy alternatives.

The structure of this review paper is as follows. We first review studies that describe how people evaluate various energy alternatives and how these evaluations relate to their acceptability ratings. According to the literature, general public acceptability of energy alternatives depends on how people evaluate collective as well as individual consequences of these alternatives. Besides the costs and benefits per se, perceived fairness of the distribution of these costs and benefits across groups in society and perceived fairness of decision making process are expected to affect acceptability, especially when energy alternatives are (to be) sited in a certain community.

Next, we focus on factors that determine why people evaluate energy alternatives in the way they do and why certain evaluations sometimes play a larger role in acceptability ratings than others. Based on the literature, we identify two key components that define evaluations and acceptability of different types of energy alternatives on a general as well as community level, namely *contextual factors* and *general psychological factors* (see Fig. 1). We define contextual factors as objective characteristics of energy alternatives determined by the context, for example energy price.[2] Actual prices of energy can define people's evaluations of how cheap or expensive an energy alternative is, thereby affecting their acceptability ratings. We define general psychological factors as subjective individual characteristics, in particular values, that may influence how people perceive objective characteristics of energy alternatives and how these perceptions affect their acceptability ratings.[3] For example, given their values, people may find price as either more or less important for their acceptability ratings and, we will argue, they may even perceive the actual costs of energy alternatives differently. Hence, we argue and show that individual values have overarching effects on evaluations and acceptability, as they define which costs and benefits of energy alternatives people find most important and likely. Based on the knowledge developed and on the integrated conceptual framework, we put forward a research agenda for further exploration of this important topic and we derive implications for energy policies. The studies that were reviewed in this paper are listed in Appendix A, where we specify key details of the studies and indicate which factors from the proposed conceptual framework they addressed.

The current review contributes to the existing literature in three important ways. First, to our best knowledge, this review is the first attempt so far to systematically integrate contextual and general psychological factors in one conceptual framework that explains evaluations and acceptability of energy alternatives. This enables us to identify how multiple contextual and general psychological factors interact when shaping evaluations and acceptability of energy alternatives, which is an important asset

[1] Wüstenhagen et al. [1] use a term *socio-political acceptance* to refer to general acceptance of energy alternatives in society. We use the term *general public acceptability* instead because in this paper we focus on acceptability by the general public rather than specifically by policy makers or other stakeholders.

[2] It is beyond the scope of this paper to discuss macro-level contextual factors that may too impact evaluations and acceptability of energy alternatives, such as economic developments, demographic developments (e.g., population growth), institutional factors (e.g., national policies in and beyond the energy domain), and cultural developments [2–4]. We narrow down the spectrum of contextual factors to those that have direct implications for the users of energy alternatives, while acknowledging that these particular factors are embedded in, and thus should not be considered in isolation from, wider societal, economic, cultural, and political contexts.

[3] Evaluations of costs and benefits and acceptability ratings are also subjective variables, and could thus be labelled as psychological factors [5]. However, they are bound to a particular energy alternative, and thus different from general psychological factors that may affect evaluations and acceptability of many different energy alternatives.

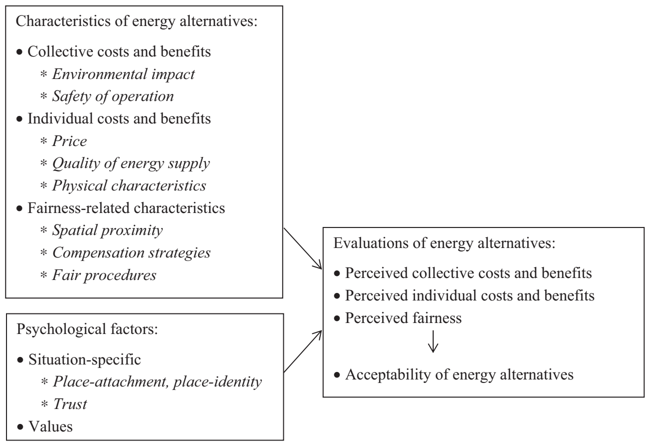


Fig. 1. Conceptual framework that explains evaluations and acceptability of energy alternatives. *Note*. The framework reflects how contextual and general psychological factors have been addressed so far in the literature, namely as independent predictors. Yet, contextual and general psychological factors interact when shaping evaluations and acceptability of energy alternatives, and should therefore be studied in combination; we elaborate on this in the research agenda presented later in this paper.

to the literature. Second, while most studies offer models for explaining evaluations and acceptability of one specific energy alternative on a specific level (i.e., general public acceptability or community acceptability), we develop a *general* conceptual framework that explains evaluations and acceptability of a wide range of energy alternatives on multiple levels. The third contribution to the literature is the research agenda where we draw major guidelines for further strengthening and extending the conceptual framework that explains evaluations and acceptability of energy alternatives.

2. Evaluations and acceptability of energy alternatives

People consider various costs and benefits when evaluating energy alternatives. A distinction can be made between perceived *collective costs and benefits*, which reflect implications for society including public safety and the environment, and perceived *individual costs and benefits*, which reflect implications for individual resources such as money, comfort, time, and effort. Both types of costs and benefits are to a certain degree important to people [6–8], and hence likely to shape general public acceptability of energy alternatives. In addition, the extent to which people think that these costs and benefits are distributed fairly across groups in society and that decision making process around energy alternatives is fair may affect acceptability. Evaluations of fairness are considered in the literature to be particularly important for community acceptability [9]. Below, we review how people evaluate energy alternates in terms of collective and individual costs and benefits and fairness, and how these evaluations relate to their acceptability ratings.

2.1. Perceived collective costs and benefits

People tend to ascribe high collective costs and low collective benefits to fossil fuels, including oil, coal, and gas, and to nuclear energy, whereas they tend to associate renewable energy sources with high collective benefits and low collective costs. Fossil fuels are typically evaluated as polluting, contributing to climate change, finite, and causing global conflicts, whilst nuclear energy bears additional associations with atomic weaponry, radioactive waste disposal, and nuclear accidents [10–13, see also 14]. Renewable energy sources, in contrast, are typically evaluated as safe and clean [10–13, see also 15]. This, however, mostly applies to wind and solar energy and less to other types of renewable energy alternatives. For example, people associate bioenergy with fossil fuels, due to the involved process of burning materials, and they thus do not see it as a very sustainable energy alternative [10]. Especially energy production from wood was not seen as environmentally friendly by young students, who were also unsure about the effects of increased use of bioenergy on food production [16]. Interestingly, only about 55% of the asked respondents recognised biomass as a renewable energy source; about 72% recognised geothermal heat and about 77% recognised hydro energy as renewables, while most respondents recognised solar (about 88%) and wind (about 93%) energy as renewable energy alternatives [12].

2.2. Perceived individual costs and benefits

When it comes to individual costs and benefits, renewable energy alternatives are evaluated somewhat less positively. For example, it was concluded in one study that people perceived the price of green electricity as higher than what they would be willing to pay (the absolute values for perceived expensiveness of green electricity were not specified, [15]). Next, wind energy has been associated with annoyances and, especially, spoiled scenery [17]. Electric heating systems in houses, which may have to replace gas heating systems when implementing renewable energy, were judged “expensive, not controllable, non-responsive, and ineffective” [10, p. 39; 13]. In comparison, fossil fuels, and especially gas, are evaluated more favourably and are seen by people as effective and reliable sources for their daily energy needs [10,13]. At the same time, there seems to be some ambiguity in people's evaluations of some individual costs and benefits of energy alternatives. For example, respondents were rather undecided (ratings close to the mid-point “neither agree nor disagree”) in their evaluations of renewable energy sources, nuclear power, and fossil fuels in terms of reliability, job creation, and expenses [12]. In addition, in some studies renewable energy sources are actually evaluated by many as relatively cheap [18].

So, people ascribe different collective and individual costs and benefits to different energy alternatives. The important question then is how these multiple evaluations translate into acceptability ratings.

2.3. Relationship between perceived costs and benefits and acceptability

Not surprisingly, the higher costs people ascribe to an energy alternative, the lower their acceptability, whereas the higher benefits they expect, the higher their acceptability, be it collective or individual costs and benefits [5]. For example, acceptability of solar and wind energy, energy produced from coal, and nuclear energy was lower when people believed that a particular energy alternative is contributing to climate change, whereas acceptability was higher if people believed that an energy alternative increases a country's energy independence [11]. The higher price participants expected to pay for green electricity when compared to conventional electricity, the less they were willing to adopt green electricity [15]. The more benefits in terms of energy price, energy security, and reduced CO_2 emissions, and the lower risks for safety, health, and the environment people associated with nuclear energy, the higher was its acceptability [19–21]. In another study, acceptability of geological and oceanic carbon capture and storage technology (CCS) was lower the more the public associated it with unforeseeable future problems (putting pollution somewhere else rather than reducing it), disturbing nature, and increasing reliance on fossil fuels; whereas acceptability of CCS was higher the more people evaluated it as allowing to use current resources while reducing CO_2 levels, giving time to find more sustainable solutions, and making a better way of living for future generations [22,23].

In some cases perceived benefits while in other cases perceived costs may be better predictors of acceptability of energy alternatives. For example, positive evaluations of social, personal, and environmental outcomes (combined measure) more strongly predicted acceptability of electricity generation from fossil fuels, nuclear energy, and hydroelectricity [24] and general public acceptability of CO_2 storage [25] than negative evaluations of these outcomes. In contrast, particularly perceived costs are considered relevant for acceptability of radioactive waste disposals [26,27]. This implies that knowing solely what costs and benefits people associate with a certain energy alternative does not yet allow to predict acceptability of that alternative, as some (collective and/or individual) costs and benefits may have higher impact on acceptability than others.

Interestingly, people are not always accurate when judging which costs and benefits influence their acceptability ratings. For example, although respondents rated the environmental impact as the most important aspect of wind farms and hence more important than the visual impact, the visual impact turned out to explain most variance in support for wind energy [17]. In another study, respondents ascribed relatively much importance to so-called instrumental aspects of local renewable energy systems, such as price and comfort, and to environmental aspects, whereas they ascribed relatively little importance to so-called symbolic aspects that indicate how much local renewable energy systems fit their personality and enable them to distinguish themselves from others [28]. Interestingly, however, particularly the symbolic aspects, next to the environmental aspects, predicted respondents' intention to adopt local renewable energy systems, whereas their beliefs about instrumental aspects of these energy systems had virtually no influence on their intention to adopt when the other factors were controlled for [28]. This suggests that comprehensive research designs are needed to examine which perceived costs and benefits have most influence on acceptability of energy alternatives, as people may not always be accurate about their true motivations. Even more important is to study contextual and general psychological factors that could explain how people come up with evaluations of costs and benefits of energy alternatives and how these evaluations translate into their acceptability ratings, as we will explain later in this paper.

2.4. Relationship between perceived fairness and acceptability

Not only evaluations of costs and benefits per se, but also the extent to which costs and benefits are believed to be distributed fairly across groups in society, which reflects perceived *distributive fairness*, can influence acceptability [9]. Perceived distributive fairness depends on how people evaluate the balance between the costs that a certain group faces and the benefits it receives, in comparison to other groups [29], which is particularly relevant when a certain community has to host an energy facility (and hence for community acceptability). If the host community bears many costs (e.g., noise, disturbed landscape, risks in case of accidents) and other groups in society mainly receive the benefits (e.g., energy security, economic growth, reduced CO_2 emissions) and little direct costs, perceived distributive fairness, and hence acceptability of the energy alternative, might be low. In one study, seeing risks as unfair and, particularly, perceiving high risks to the health of local people reduced support for a nuclear waste repository [30]. Another study explored several cases of hosting renewable energy alternatives within local communities and found that a wind farm project was viewed rather negatively in a community where people thought that most of the benefits were flowing to a few local farmers rather than to the community as a whole [31]. In contrast, people in another community expressed rather positive views towards a ground source heat pump technology, which enabled all community members to use a well-heated village hall [31]. Besides everyone benefiting equally from the project, the latter community also reported fairer decision making process than the former community, which could (partly) account for different views towards each project [31]; we elaborate on perceived procedural fairness below.

The extent to which people believe that decisions regarding (implementation of) energy alternatives are taken in a fair way, namely perceived *procedural fairness*, has also been linked to (mostly community) acceptability [9,29]. Indeed, if asked, citizens emphasise that fair decision making process is important to them. For example, before as well as after the implementation of a wind farm project in South Wales (the UK), the majority of citizens agreed with the statement "Wind farms should always be developed in partnership with local communities" [32]. In an Australian study on acceptability of a wind farm project, people were concerned with the fairness of decision making procedures being employed (e.g., adequate information, possibility to participate and to be heard) and integrated them in their acceptability judgements [33]. A review of other studies on renewable energy developments revealed that, in general, people wish to be informed about and to have a say in energy developments, although only a minority expect their views to be taken seriously by decision makers [34]. It is useful to keep in mind, however, that the extent to which people rate certain aspects important does not necessarily correspond to the actual impact of these aspects on their acceptability ratings, as mentioned before [17,28]. Yet, case studies in Switzerland [35], Germany [36], and Native American communities [37] suggested that lack of perceived fairness in decision making could (partly) account for public opposition towards nuclear waste disposals. A study on acceptability of CCS in Barendrecht (the Netherlands) measured people's perceived (un)fairness of decision making process, as well as the perceived influence of energy industry and local people in decision making, and found that these perceptions explained a substantial variance in generally rather negative attitudes towards the CCS project, next to perceived safety, trust in decision makers, and people's expected fall in property value [38].

The studies reviewed so far provide important insight into how people evaluate collective and individual costs and benefits and fairness of various energy alternatives, and how these evaluations relate to acceptability on a general and community level. The next step is to find out why people evaluate energy alternatives in the way they do, and why certain evaluations sometimes play a larger role in acceptability than others. Below, we will discuss contextual and general psychological factors that are likely to underpin evaluations and acceptability of energy alternatives.

3. Contextual factors shaping evaluations and acceptability of energy alternatives

Every energy alternative comes with its costs and benefits that are determined by the context and "delivered" to the public upon implementation of these alternatives. The actual costs and benefits of energy alternatives influence people's evaluations and acceptability of these alternatives, and thus contextual changes that reduce the costs and increase the benefits could have significant effects on acceptability. Such interventions may be particularly important when severe contextual barriers for acceptability exist (e.g., unaffordable price, hazardous pollution levels) [39,40]. It should be noted, however, that even given the very same characteristics of energy alternatives, people may perceive them differently and come up with different acceptability ratings, due to the influence of general psychological factors, which we will discuss later in this paper. Below, we review some key context-dependent collective costs and benefits (such as *environmental*

impact and *safety of operation*) and individual costs and benefits (including *price*, *quality of energy supply*, and *physical characteristics*) of energy alternatives,[4] and describe how they relate to acceptability. We also discuss specifically fairness-related characteristics of energy alternatives (*spatial proximity*, *compensation*, and *fair procedures*) that are considered in the literature to be particularly important for community acceptability.

3.1. Collective costs and benefits of energy alternatives

3.1.1. Environmental impact

It is a highly complex task to assess environmental impact of a particular energy alternative throughout its life cycle, and even experts tend to disagree on that. This makes studying the effects of *actual* environmental impact of energy alternatives on acceptability difficult, and it typically boils down to exploring how people evaluate energy alternatives that have been *claimed* to have a relatively low or high environmental impact. As indicated before, people evaluate renewable energy sources as having lower environmental impact than fossil fuels and nuclear energy. However, it is unclear which exact indicators of environmental impact (e.g., CO_2 emissions, waste materials) account for these differences. For example, nuclear energy has been long promoted as a low-carbon energy alternative, but it is nevertheless evaluated as having relatively large contribution to climate change, larger than renewable energy, although somewhat smaller than energy produced from coal [11]. Also in other studies nuclear energy scored rather low on perceived environmental benefits, with people only "reluctantly" accepting it if having come to a conclusion that there is no other way to combat climate change and at the same time expressing strong preference for alternative sustainable solutions [14,41,42]. Interestingly, an experimental framing (versus no framing) of nuclear energy as a potential solution to climate change had hardly any effect on acceptability [42]. However, the experimental framing condition included a statement about both pros and cons of nuclear energy for mitigating climate change (while the control condition had no such statements), which could have balanced out the positive and the negative effects of this framing on acceptability [42]. In the same study, acceptability of new nuclear power stations, which was based on the condition that these stations would help to solve climate problems, was somewhat higher than acceptability of nuclear power per se. However, it is unclear to what extent this difference was driven merely by the clause "if it would help" rather than by actually considering new nuclear build as a sustainable solution [42]. Future studies should follow up this work and specify the effects of (claimed) environmental impact of energy alternatives on acceptability, and the unique effects of various indicators of environmental impact (e.g., CO_2 emissions, waste materials). Notably, certain types of fossil fuels, such as natural gas and shale gas, have been promoted as having relatively low environmental impact. Some preliminary evidence indicates that natural gas is seen as somewhat more environmentally friendly than other fossil fuels [12], but nevertheless evaluated as dirty and contaminating [43]. Research on perceived environmental impact and acceptability of shale gas and oil is still at its infancy, but there is some evidence to suggest that these unconventional energy sources are associated more with environmental costs rather than benefits, especially by opponents [44 and references therein, 45]. A study found that informing people about the possibility to reduce CO_2 emissions in the atmosphere by implementing an offshore CCS technology increased acceptability of this technology, although acceptability also depended on other factors, for example whether or not CCS is combined with the introduction of renewable energy sources to reduce CO_2 [46]. People saw some environmental benefits of CCS (e.g., abating climate change, "buying time" to develop other solutions), but they doubted whether it could be a long-term sustainable solution and associated it with high risks for public health and the environment (e.g., accidents, leakage) [46].

3.1.2. Safety of operation

Safety of operation can influence how people evaluate implications of energy alternatives for public health, as well as for the environment. Just like with environmental impact, it is difficult to evaluate actual safety of operation for different energy alternatives, as in most cases it means assessment of potential risks rather than facts. One way to study the effects of safety of operation on acceptability is by measuring acceptability before and after safety is violated, as, for example, in case of nuclear accidents. A decrease in support for nuclear energy was observed after the three major nuclear accidents, namely the Three-mile Island, Chernobyl, and Fukushima [47,48] and after a nuclear accident in Tokai, Japan [49]. A study in Switzerland found moderate negative effects of the Fukushima accident on acceptability of nuclear energy among the Swiss population (measured before, immediately after, and half a year after the accident) and observed that people held similar attitudes towards this energy alternative before and after the accident [50]. Such robust attitudes may be rooted in general psychological factors, described later in this paper.

3.2. Individual costs and benefits of energy alternatives

3.2.1. Price

Energy costs can be an important contextual factor influencing acceptability. Public surveys indicate that people are not in favour of paying a price premium for increased use of renewable energy sources in the future [18]. Note, however, that people may be motivated to indicate that they are willing to pay less than they would actually find acceptable, so as to steer policy making and achieve lower energy prices. In fact, when provided with future clean energy scenarios (80% clean energy by the year 2035) with a certain increase in their energy bill (8 different amounts varied in a between-subjects design, from min. US$5 to max. US$155), the majority of respondents supported the scenarios, although support decreased gradually from over 70% supporting an increase of US$5–35 to approximately 50% supporting an increase of US$135–155 (there was a significant negative cost effect on acceptability [51]). Interestingly, these respondents were somewhat more likely to support energy systems that solely relied on renewable energy than energy systems that also included gas or nuclear energy [51]. There is more evidence to suggest that people find rises in energy bills more acceptable if they are to pay for relatively desirable elements, such as renewable energy, than for relatively unwanted elements, such as fossil fuels [10,13]. Besides the absolute price, other cost aspects may influence acceptability, for example, people prefer stable over unstable energy prices, even if that costs them more money in the end [10,13].

3.2.2. Quality of energy supply

Quality of energy supply can have implications for people's daily comfort and hence affect acceptability. Renewable energy sources are often characterised by intermittency, meaning that they can encompass shortages, delays, and shut-downs in energy

[4] Naturally, the distinction between collective and individual costs and benefits of energy alternatives is somewhat artificial, as these factors may be related. For example, CO_2 emissions may not only have implications for the environment but also influence people (i.e., individual costs and benefits). Nevertheless, we consider this distinction useful for a systematic literature review, and we focus on the collective and individual costs and benefits that have been mostly addressed as such in the literature.

supply, which might reduce acceptability [10,52]. To use renewable energy, people may need to adjust their behaviours to availability of energy (e.g., shifting energy use to times where energy is produced abundantly), which, deriving from literature on acceptability of energy policies [53], might be seen as too effortful by people and result in a lower acceptability of renewable energy alternatives. Energy technology can play an important role here and facilitate new and/or different energy consumption behaviours by making these behaviours easier, helping people learn and monitor their behaviours, and even activating social behavioural norms [54]. For example, when a "Smart Wash" technology informed people about energy availability and, if people wanted, autonomously regulated their laundry times, people indeed started matching their laundry times and, in some cases, even other electricity consumption behaviours (e.g., the use of dryer, dishwasher) with availability of local solar electricity [55]. Thus, energy alternatives may be more acceptable if they can be adopted and used easily and do not interrupt the rhythms of people's everyday life.

3.2.3. Physical characteristics

Physical characteristics of energy alternatives may influence people's evaluations of, for example, aesthetics and noise. Sometimes it might be difficult to pinpoint which physical characteristics account for which evaluations, as, for example, it was suggested that people's perceived sound annoyance from wind turbines can be influenced by their perceived visual interference of wind turbines [56]. A review of studies on perceptions of wind farms revealed a tendency of people to prefer small-scale wind farms over large-scale developments [34]. Next, higher levels of support were found for offshore than onshore wind farms [13]. However, it is not clear what type of evaluations (e.g., aesthetics, noise, disturbance of landscape) drives these preferences; more (experimental) studies are needed to explore this in depth.

3.3. Fairness-related characteristics of energy alternatives

3.3.1. Spatial proximity

As noted earlier, perceived distributive fairness of energy alternatives might be low if a host community bears all the costs while other groups in society enjoy solely the benefits. Therefore, spatial proximity to energy alternatives have been considered an important factor for community acceptability, giving roots to a so-called NIMBY (Not In My BackYard) phenomenon, which implies that people may accept energy alternatives in general, but not when these alternatives are deployed in their immediate vicinity. For example, while people generally express much support towards renewable energy, actual implementation of renewable energy facilities (e.g., wind farms) is often met with opposition [17,34]. Similarly, attitudes towards CO_2 storage in general were more positive than attitudes towards CO_2 storage in one's immediate vicinity [25,57]. It must be noted, however, that NIMBY can be a highly over-simplified and misleading concept, as it always explains low acceptability in terms of a sole motive to not have energy alternatives in one's vicinity, while at the same time downplaying potential genuine concerns of (local) people with regard to collective risks for the environment and future generations, trust in regulators, and perceived distributive and procedural fairness [17,34,58]. A comparison between evaluations and acceptability of energy alternatives in general versus a specific energy development in one's backyard is not a valid one for establishing the NIMBY effect, since the costs and benefits of a specific project are not brought into people's consideration when asking for their general evaluations and acceptability ratings. In fact, a study using a between-subjects design to measure acceptability of CCS either in one's close vicinity or somewhere else did not find support for the NIMBY effect, as respondents in both experimental groups were equally inclined to protest again CCS [23]. The less they trusted the government and the more they associated CCS with collective risks rather than collective benefits, the more inclined people were to protest against CCS, irrespective of whether it would be implemented within or outside their residential area. Only the perceived risk to the safety of local people predicted protesting intentions better among onsite residents than among offsite residents [23]. Interestingly, people tend to mostly object *new* energy developments in their locality, whereas people living close to *existing* energy alternatives generally do not report lower acceptability judgments and even report higher acceptability judgements than people living farther away [34,58] or than what they reported before the energy facility was implemented [17]. The reason why local people would evaluate existing energy alternatives more positively (or, rather, less negatively) than planned energy alternatives is unclear and requires further investigation.

3.3.2. Compensation strategies

If relatively high costs of energy alternatives to a certain group in society are inevitable, distributive fairness can be pursued by increasing benefits to that community [9]. Financial compensations are by far the most frequently considered strategy in this respect. However, a comprehensive review of the literature in the field demonstrates mixed evidence for the effectiveness of this strategy, with financial compensations increasing public support in some cases but not in other cases, and sometimes even reducing public support [59]. When asked, only a minority of respondents stated that they would accept a nuclear waste repository in their immediate vicinity if financial compensation was provided [30]. Also, offering (versus not offering) a monetary compensation did not increase citizens' willingness to vote in favour of a nuclear waste repository (Kunreuther, Easterling, Desvousges, and Slovic, 1990, cited by Ter Mors et al. [59]) and even reduced support for a nuclear waste repository implying that it was counterproductive [60]. Especially for energy alternatives associated with high collective costs, financial compensations may be ineffective and can be perceived as immoral by people (Elster, 1992 and Gerrard, 1994, cited by Ter Mors et al. [59]).[5] Some responses, for example "I am not for sale" [30, p. 90], suggest that people may feel insulted or suspect bribery attempts [26,59,61]. In such cases, compensations in a form of collective goods rather than personal monetary incentives may be more adequate and less likely to evoke resistance [59,62]. Indeed, in-kind measures, such establishing new public services, were seen as more acceptable by people than direct monetary payments for siting facilities associated with collective costs, among which a nuclear waste repository [63]. In the same study, implementing strict safety measures (e.g., regular inspections of whether a facility meets regulations) turned out to be a more effective strategy for increasing acceptability of nuclear waste repository than offering financial compensations [63]. Possibly, financial compensations become more attractive to people when energy alternatives are seen as imposing individual rather than collective costs, like in case of renewable energy sources. Indeed, a study on acceptability of electrical generating

[5] A related argument is that primarily the size of perceived costs influences the effectiveness of compensation strategies, with these strategies being more effective when the perceived costs are low and less effective when the perceived costs are high [59]. We nevertheless assume that the type of costs plays a more important role. Specifically, perceived high individual costs can potentially be offset by a larger financial compensation, whereas that is unlikely for perceived (high) collective costs. However, in order to test this assumption, experimental studies are needed that would measure how public acceptability changes as a function of systematic differences in the size and type of perceived costs, and the size of financial compensation.

windmills in the mountains of North Carolina (the US) found that people's willingness to accept wind technology increased as a function of the proposed higher reductions in their energy bills [64]. Interestingly, individuals who participated or were willing to participate in a Green energy programme required lower compensation for accepting wind technology, whereas individuals who retired to the mountains and/or had ancestors in the region required higher compensation [64]. Next, in a study on a wind farm project in South Wales (the UK), many believed that wind farms should not even be developed unless they are owned by a local community [32]. A review of other studies revealed that ownership of wind energy (e.g., having shares in wind turbines, being a member of a wind co-operative) results in higher acceptability of this energy alternative [34]. Although these findings could suggest that potential financial benefits from renewable energy alternatives increase acceptability via perceived distributive fairness, this hypothesis was not explicitly tested in the above studies. In fact, having shares in energy developments could (also) operate via perceived procedural fairness, as people may feel more involved and hence see the decision making process as fair. We discuss the effects of fair procedures on acceptability below.

3.3.3. Fair procedures

The extent to which implementation of energy alternatives entails qualities of fair procedures, such as information provision and transparency, opportunities for participation (sometimes referred to as “voice”), and impartial and respecting position of authorities, may influence perceived procedural fairness and community acceptability [9,29]. Building on findings on acceptability of waste infrastructure, Wolsink [17] argued that for a successful implementation of renewable energy technology (in this case wind energy), it is important to follow collaborative rather than hierarchical top-down decision making procedures. Similarly, based on the insights from several local renewable energy projects, Walker and Devine-Wright [65] concluded that the more involved people were in project development, the more support they expressed for a specific project and for renewable energy in general. Interestingly, an experimental study tested the effects of fair procedures on acceptability of decisions regarding CCS [66]. People were more likely to accept decisions from political authority when they learned that environmental NGOs and industrial organisations were involved in decision making process, than when they learned that none, or only one, of these parties were involved in decision making [66]. The positive effects of fair procedures on acceptability were moderated by increased trust in decision makers, and particularly people who had some (versus no) knowledge about CCS desired public voice in decision making and demonstrated strongest effects of fair procedures (i.e., involving public representatives in decision making) on acceptability and trust [66]. More (experimental) studies are needed to systematically test the effects of various elements of decision making procedures on perceived procedural fairness and acceptability of energy alternatives.

In this section, we focused on contextual factors influencing acceptability of energy alternatives. We will now introduce another important predictor, namely general psychological factors.

4. General psychological factors shaping evaluations and acceptability of energy alternatives

Even given the same characteristics of energy alternatives, people may come up with different evaluations of costs and benefits and fairness, and report different levels of acceptability. For example, there is a long tradition of divided public opinion on nuclear energy with, at sometimes, the supporters and opponents representing almost equal shares of the population [47]. While supporters of nuclear energy advocate its contribution to reduced greenhouse gases, opponents, on the other hand, see it as highly risky rather than beneficial for the environment [19,20]. Disagreement also exists regarding various costs and benefits (i.e., collective and individual) of other energy alternatives, such as hydrogen (see [67] and the references therein) and recently widely debated shale oil and gas [44,45]. In general, people tend to see energy alternatives in an overly positive or a negative light. That is, they either ascribe high benefits and low costs or, on the contrary, low benefits and high cost to a certain energy alternative [20,68, see also 69]. Such patterns are difficult to explain if only focusing on contextual factors, as none of the current energy alternatives is likely to have only costs or benefits, but rather a mixture of both. People's overly positive or negative evaluations have mostly been attributed to a positive or a negative feeling about the evaluation object [68,70], but the question remains what gives roots to such a feeling. We propose that studying general psychological factors could shed light on this question. Below, we lay out key general psychological factors that have been identified in the literature as important for evaluations and acceptability of energy alternatives, namely *place-attachment and place-identity*, *trust*, and *individual values*.[6] Place-attachment and place-identity and trust are situation-specific and may vary depending on, among others, the location where energy alternatives are implemented, the type of energy alternative, and the actors involved with energy alternatives. Values, on the other hand, are abstract life goals or ideals that define what is generally important for people in their lives [71,72]. As such, values may have an overarching effect and influence evaluations and acceptability of various energy alternatives on a general and community level, as we will argue later in this section.

4.1. Place-attachment and place-identity

Place-attachment and place-identity have been introduced as important psychological factors to explain people's evaluations and acceptability of energy alternatives in their close environment, and hence as an alternative to the over-simplified NIMBY approach [34,58,73,74]. Place-attachment refers to one's emotional bonds with the local area, whereas place-identity reflects the extent to which physical and symbolic aspects of the place contribute to one's sense of self or identity (see [34,58,75] for conceptualization of these factors in the energy domain and the references therein). Some energy developments may be seen as disrupting place-attachment or threatening place-identity, thus reducing acceptability of these developments [58]. Indeed, a Norwegian study revealed that the more people felt emotionally attached to the local natural areas (potentially) affected by a hydropower project, the stronger were their negative attitudes towards this project [75]. Notably, however, energy alternatives should not necessarily be interpreted as disturbing or threatening the local area, and thus the effects of place-attachment and place-identity on acceptability will not always be negative [34,74]. For example, a study in the UK revealed negative (modest) effects of place-attachment on acceptability of a large offshore wind farm, but only in a town where people perceived the wind farm as disrupting the (salient) natural and restorative identity of the locality, while no such consistent negative effects were found in a town where people saw the place as being “run down” and perceived the wind farm less as a threat and, to some extent, even as an opportunity [74]. A study comparing acceptability of an already built tidal energy convertor

[6] Several studies include worldviews as general psychological factors (see Appendix A). However, we do not include worldviews in the conceptual framework, mainly due to the lack of empirical support for the effects of worldviews on evaluations and acceptability of energy alternatives (see [30,95]).

across two neighbouring villages in Ireland revealed that place-attachment resulted in less negative emotions towards the convertor in both villages and even resulted in more positive emotions in one village, where the convertor might have been perceived as enhancing the local area [73]. Even participants who were generally against onshore wind farms admitted that in certain areas wind turbines may enhance, or at least not hamper, the "character" of the area [10]. It has been proposed that the extent to which citizens see energy developments as threatening the locality depends on their trust in involved actors. In the above study in the UK the negative effects of place-attachment on acceptability of the wind farm were particularly pronounced for people who trusted the opposition group and did not trust the developer [74]; we elaborate on trust in the following section. Later, we will argue that the influences of both trust and place-attachment and place-identity on acceptability of energy alternatives in a community may depend on people's values.

4.2. Trust

Development, production, distribution, and use of different energy alternatives are complex matters that can only be fully grasped by people with specific knowledge and expertise. This means that the public need to rely on other parties (e.g., energy companies, national and local governments, interest groups, knowledge institutes) when evaluating costs and benefits of energy alternatives. Hence, the extent to which people trust these parties is an important factor for acceptability [5]. In the literature, trust has been defined as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another" [76, p. 395]. Trust is partly a personal predisposition and can also be defined by the context (e.g., which parties are involved with energy alternatives and how they perform). We classify trust as a general psychological factor that can make energy alternatives appear in an overly positive or a negative light. It has indeed been proposed that trust influences evaluations of costs and benefits, which, in turn, shapes acceptability ratings [77,78]. More trust in regulators was linked to lower perceived risks and, consequently, to higher acceptability of nuclear power [79] and a radioactive waste repository [27]. Trust was found to be particularly influential when people knew little about a (potential) hazard, which suggests that trust served as a heuristic for their evaluations [80]. For example, nuclear power and hydroelectric power scored relatively low on self-rated knowledge and for both of them people with higher trust in responsible parties believed that these energy alternatives were associated with lower risks and higher benefits, whereas for other activities and technologies that were more familiar to people (e.g., home appliances, bicycles), no (strong) relationship between trust and perceived costs and benefits were found [80]. Trust also shaped evaluations of costs and benefits of a new hydrogen system in transport [81], as well as evaluations and acceptability of a relatively unfamiliar CO_2 storage technology [25]. More specifically, trust induced affect towards a given technology, which, in turn, led to evaluations of costs and benefits [81] and, given an energy alternative in one's immediate vicinity, directly to acceptability ratings [25]. This suggests that trust could potentially define whether people have an overall positive or a negative feeling about an energy alternative, which eventually colours their evaluations and acceptability ratings. Interestingly, in a study on acceptability of energy alternatives in Chile, trust in responsible parties influenced evaluations of costs and benefits and, consequently, acceptability of fossil fuels, hydro-energy, and nuclear energy, whereas trust was not related to evaluations of costs and benefits and acceptability of renewable energy alternatives, such as solar, tidal, and wind energy [24]. The authors suggested that trust in regulators is particularly important for controversial energy alternatives such as nuclear power, as people need to trust someone in mitigating noxious consequences. Producing energy from renewable sources, on the other hand, is not perceived as posing such severe threats and hence trust in regulators may become less relevant for evaluations of its risks and benefits and acceptability ratings [24]. Yet, Sjoberg [82] argued that trust in regulators can only play a modest role in shaping perceived risks of controversial technologies such as nuclear power, because people consider these risks as "unknown" and do not expect even experts to be able to exactly know the risks and to cope with them. Importantly, most studies on the relationship between trust and evaluations and acceptability of energy alternatives are correlational, and hence do not allow to pin down the cause and the consequence in this relationship. For example, trust could indeed shape people's evaluations and acceptability of energy alternatives, but, alternatively, people could adjust their judgements on the trustworthiness of responsible parties based on how beneficial or costly and how acceptable they find a specific energy alternative [cf., 70,83]. Experimental studies are needed to assess the extent to which different levels of trust (as manipulated by the experimenter) can influence evaluations and acceptability of energy alternatives. These studies are rare, with a few exceptions discussed below.

It has been argued that people base their trust judgements on the competencies (i.e., experience and expertise) of the involved parties as well as on their integrity (i.e., honesty, openness, and concern for public interests) [84,85]. Indeed, providing positive (versus negative) information about competence and integrity of parties involved in CCS development resulted in higher perceived trust in these parties [85]. Interestingly, however, people's evaluations of costs and benefits and acceptability of CCS were only affected by the views of a certain party towards CCS (in favour or against) in the condition with positive (but not negative) competence-related information and in the condition with negative (but not positive) integrity-related information [85]. These results thus suggest that the valence of information about involved parties can influence trust in these parties, whereas it depends on the type of information (competence- or integrity-related) whether people will rely on the position of these parties towards an energy alternative for their own judgments of that alternative.

It was found that information about (perceived) values of involved parties influence trust in these parties, including social trust (i.e., trust in integrity) as well as confidence (i.e., trust in competence), whereas information about their performance could only, if even, influence confidence [84]. Interestingly, people tend to put more trust in involved parties and the related technology (e.g., nuclear energy) if they see these parties as endorsing values similar to their own [86]. A study on acceptability of CO_2 storage found that when people perceived themselves and professional parties as sharing similar goals and values, they expected these parties to not only have good intentions but also sufficient skills and competencies to pursue these intentions [57]. These findings suggest that individual values may play an important role in trust judgements. We propose that values could serve as a third factor that influences both trust and evaluations and acceptability of energy alternatives. Specifically, people may refer to their own values when coming up with trust judgements for responsible parties. Also, values may influence how people develop their evaluations and acceptability ratings of energy alternatives, which can then be used as a heuristic for their trust judgements. We elaborate on the role of values in the next section.

4.3. Individual values

Values are conceptualised as life goals or ideals that define what is important to people and what consequences they strive for in their lives in general [71,72]. Values are general psychological factors that guide a wide range of specific attitudes, beliefs, preferences, and behaviours [87–90], and have been proposed to play an important role in acceptability of energy alternatives

[10,13,20,26,79,91]. In the environmental domain, where collective and individual interests are often in conflict [2], a distinction between self-transcendence and self-enhancement values has been proven particularly relevant for explaining evaluations and acceptability [92–97]. Self-transcendence values refer to primarily considering collective outcomes, with two main types of these values being distinguished in the environmental domain: altruistic values, focusing on the well-being of other people and society, and biospheric values, focusing on environmental quality. Self-enhancement values, on the other hand, drive one's attention to individual costs and benefits. In the environmental domain, self-enhancement values encompass egoistic values, focusing on safeguarding and promoting one's personal resources, such as wealth and status, and hedonic values, focusing on improving the way one feels, such as improving comfort and pleasure [98]. Accordingly, we reason that values define which costs and benefits of energy alternatives are most important to people and hence guide their acceptability ratings. Specifically, the stronger their altruistic and/or biospheric values, the more likely people are to consider collective consequences of energy alternatives and to accept alternatives with high perceived collective benefits and low perceived collective costs, whereas the stronger their egoistic and/or hedonic values, the more likely they are to consider direct individual consequences and to accept energy alternatives with high perceived individual benefits and low perceived costs. It has indeed been found that the more people value the environment and the well-being of others, the less support they express for nuclear power [14,20,79], whereas more support for this energy alternative stems from egoistic values [20] and traditional values (e.g., security and discipline) [79]. In another study, altruistic and biospheric values bolstered, whereas traditional values mitigated acceptability of wind energy [91].

Self-transcendence values were found to give roots to environmental concern, defined as the extent to which one is aware of environmental problems, believes that these problems are caused by human behaviour, and takes responsibility for tackling these problems [93,96,99]. In turn, higher concern with the environment resulted in more favourable attitudes towards renewable energy [15,100,101] and less favourable attitudes towards nuclear power [14,100] and CCS [22]. When asked which energy-related areas the (Swedish) government should finance most, respondents with stronger pro-environmental attitudes prioritised renewable energy sources and removal of CO_2 from the atmosphere, whereas respondents with weaker pro-environmental attitudes prioritised nuclear power and nuclear waste disposal [102]. Thus, (self-transcendence) values may influence acceptability via environmental concern. Yet, it is important to conceptually differentiate values and environmental concern [95]. Values, in comparison to environmental concern, are not confined to environmental motivations and also include altruistic, hedonic, and egoistic motivations. Values were found to be better predictors of pro-environmental norms and intentions than environmental concern [95].

So values can influence which costs and benefits play they key role in acceptability ratings. But can values also influence evaluations of costs and benefits and, even more interestingly, make energy alternatives appear in an overly positive or a negative light? Evidence suggests that they can. As explained above, trust might colour people's evaluations of costs and benefits of energy alternatives, while trust itself can be influenced by values. Specifically, people trust parties that they believe share similar values as their own [57,86], which makes it plausible that people with different values trust different parties. However, the full chain of relationship between values, trust, perceived costs and benefits, and acceptability needs to be tested in future research.

There is also evidence to suggest that values can directly influence evaluations of costs and benefits of energy alternatives. For example, stronger biospheric values were found to only correlate with the perceived risks but not with the perceived benefits of nuclear energy, whereas stronger egoistic values correlated only with the perceived benefits but not with the perceived risks of nuclear energy [20]. Interestingly, the widely promoted potential of nuclear energy to reduce CO_2 emissions was least considered as likely by people with strong biospheric values, for whom this aspect should be particularly important, whereas it was considered as most likely by people with strong egoistic values, for whom this aspect should be somewhat less important [20]. Next, altruistic values predicted belief that wind farms have positive economic effects for communities, whereas egoistic values, typically associated with economic interests, did not influence this belief, and traditional values diminished this belief [91]. Interestingly, the author put forward a possibility that “positive attitudes towards the development of renewables biases people with altruistic values to expect wind farms to have economic benefits” [91, p. 197]. Thus, people may see energy alternatives that support their values in an overly positive light, with high benefits and low costs, whereas they may see energy alternatives that threaten their values in an overly negative light, with low benefits and high costs. Even evaluations of costs and benefits that are not particularly important to people on the basis of their values may come under the influence of the value-based judgements of their likelihood. This assumption builds on preliminary evidence and calls for further investigation.

When discussing fairness-related characteristics of energy alternatives, particularly the compensations strategies, we argued that people may perceive trade-offs between collective costs and individual benefits as immoral, unfair, and unacceptable. Similarly, it was found that feelings of moral obligation guided intention to act against nuclear energy, which is associated with high collective costs [19]. In another study, feelings of moral obligation roughly equally predicted intention to act against and in favour of hydrogen refuelling stations, which was, according to the authors, due to hydrogen fuel being associated with mixed collective costs and benefits [67]. It has been proposed that people engage in either deontological or consequential reasoning when evaluating objects and events [61,103]. Deontological reasoning implies that people focus primarily on moral rightness or wrongness of an action per se, irrespective of eventual costs and benefits, whereas consequential reasoning means that people focus particularly on maximising benefits and minimising costs. We suggest that it might depend on people's values whether people engage in deontological or consequential reasoning when evaluating energy alternatives with high collective costs. People with strong altruistic and/or biospheric values may see such energy alternatives as unfair and oppose them, despite any potential individual benefits of these alternatives. People with strong egoistic and/or hedonic values, on the other hand, may adopt a more consequential reasoning and hence accept the trade-off between collective costs and individual benefits as long as they consider individual benefits big enough to compensate for the costs. This assumption requires empirical investigation.

We argued that the influence of trust on community acceptability of energy alternatives may depend on values, since trust can be rooted in people's values. Additionally, we propose that the influence of place-attachment and place-identity on community acceptability of energy alternatives may also be sensitive to values. Specifically, people may be more likely to perceive energy alternatives as threatening their locality if these alternatives threaten their important values, see [104]. In this way, values may interact with place-attachment and place-identity when shaping evaluations and acceptability of energy alternatives. Specifically, place-attachment and place-identity may have strong negative effects on evaluations and acceptability of energy alternatives in a specific

place if these alternatives threaten important values of the local people. In contrast, place-attachment and place-identity may have positive effects on evaluations and acceptability if energy alternatives are seen as supporting the important values of the local people.

5. Research agenda

We reviewed theoretical and empirical studies following the integrated conceptual framework that explains evaluations and acceptability of energy alternatives (see Fig. 1). In this section, we develop a research agenda for future exploration of this important topic, based on the knowledge developed. First, we lay out possibilities for strengthening the current knowledge basis for the conceptual framework that explains evaluations and acceptability of energy alternatives. Second, we stress the need to extend the conceptual framework by proposing new relationships between key variables in the framework to be tested in future research.

5.1. Strengthening current knowledge on factors explaining evaluations and acceptability of energy alternatives

A great amount of empirical work describes how people evaluate different energy alternatives in terms of various costs and benefits and fairness. A timely and important question now is why people evaluate energy alternatives in the way they do and how these evaluations translate into their acceptability ratings. Our review reveals that some important first steps have been made to address this issue, although as yet most studies focused on a limited set of contextual or general psychological factors predicting evaluations and acceptability of energy alternatives. We integrated contextual and general psychological factors into a general conceptual framework that aims to provide a comprehensive view on which factors play a key role in this respect. We reviewed the literature in light of this framework, and based on this, we already indicated various interesting questions that could be addressed in future research. In this section, we provide guidelines for further studies to test and validate the proposed conceptual framework.

Certain parts of the conceptual framework, although studied to some extent, could benefit from a systematic theory-driven approach and multi-method empirical testing. For example, an important question concerns the relationship between objective characteristics of energy alternatives (i.e., contextual factors) and people's subjective evaluations and acceptability of these alternatives. Only a limited number of context-dependent costs and benefits have been addressed in the literature so far, while it is likely that many other important contextual factors could influence evaluations and acceptability. It is important to specify the influence of different contextual factors on evaluations and acceptability, separately as well as in combination, before deciding which factors are most important and should be addressed in intervention strategies. So far, studies have usually compared energy alternatives that differ on many contextual factors (e.g., comparing fossil fuels, nuclear energy, and renewable energy sources), making it difficult to conclude to what extent different characteristics of these alternatives account for observed variance in evaluations and acceptability. Several studies compared evaluations and acceptability of the same energy alternative before and after important contextual changes took place, for example as in case of nuclear accidents. However, even these studies cannot rule out the possibility that other contextual factors could have guided the observed results, for instance changes in (nuclear) energy policy. We propose that next to studying real life energy alternatives that differ on many contextual factors, it is important to conduct experimental studies in which contextual factors are manipulated while keeping other factors constant. This enables us to examine whether evaluations and acceptability change across different levels of a specific contextual factor, as well as how these changes depend on other, systematically manipulated, contextual factors. Importantly, interventions aimed at changing the context of energy alternatives (e.g., reducing prices) could be first tested in controlled experiments to assess whether the interventions have the intended effects on evaluations and acceptability, and to compare these effects with the effects of other possible interventions (e.g., improving safety measures) before actually implementing them on a large scale in practice.

Future studies could further add to the current understanding of the effects of general psychological factors on evaluations and acceptability of energy alternatives. Especially the interaction effects between different psychological factors need to be investigated, for instance the interplay between individual values and place-attachment and place-identity. Also, the development of general psychological factors, including trust, values, and place-attachment and place-identity, begs (further) investigation, and particularly whether and under which conditions these factors are likely to change. For example, values are considered to be a relatively stable personal predisposition, yet the relative importance of values might change, for instance due to new experiences in life [105,106]. Value change, however, remains a highly under-researched topic, calling for more (longitudinal) studies.

It is important to systematically test the proposed conceptual framework across a wide range of energy alternatives, including evaluations and acceptability on a general as well as community level. So far, the effects of different factors in the framework have been tested for different energy alternatives, which does not allow to conclude whether these effects generalise to evaluations and acceptability of other energy alternatives as well. Furthermore, while the effects of some factors (e.g., perceived costs and benefits) have mostly been studied for general public acceptability of energy alternatives, the effects of other factors (e.g., perceived fairness) have been particularly linked to community acceptability. Evidence suggests, however, that the key factors from the conceptual framework can affect evaluations and acceptability on both general and community levels. For example, the perceived consequences of CCS and trust in the involved actors predicted acceptability of CCS irrespective of whether it would be implemented within people's own community or somewhere else [23]. It is important to consider multiple factors influencing general and community acceptability, in order to prevent such over-simplified assumptions about evaluations and acceptability of energy alternatives as the widely embedded NIMBY concept (i.e., assuming that community acceptability is driven by different, mainly egoistic, reasons than acceptability in general). In addition, it could be tested whether the proposed framework also explains other types of acceptability, such as market acceptability, and people's evaluations of energy alternatives in their role of voters, community members, and consumers [1].

5.2. Extending the conceptual framework that explains evaluations and acceptability of energy alternatives

In this review paper, we relied on the existing literature to derive a general conceptual framework acceptability of energy alternatives. In this section, we address issues that go beyond the current understanding of evaluations and acceptability of energy alternatives. Most importantly, we stress the need to extend the conceptual framework by proposing new relationships between key variables in the framework to be studied in future research, as illustrated in Fig. 2. The solid lines in Fig. 2 show the relationships

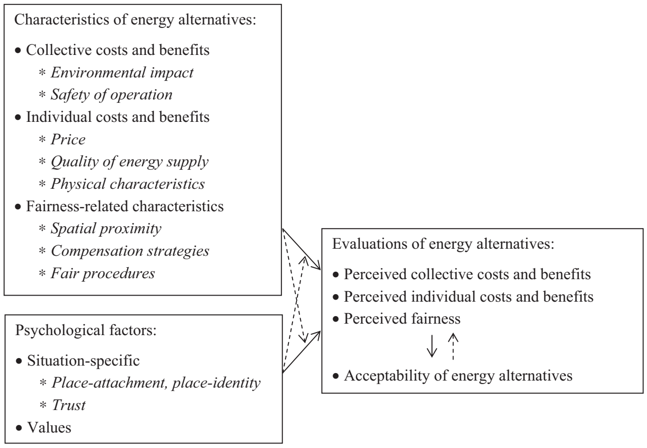


Fig. 2. Extended conceptual framework to explain evaluations and acceptability of energy alternatives. The solid lines reflect the relationships that have been addressed in the literature so far, whereas the dashed lines reflect additional relationships to be addressed in future research.

that have been addressed in the literature so far, whereas the dashed lines reflect the proposed new research questions.

Our review clearly reveals that contextual and psychological factors are usually studied separately and hardly ever studied in combination when explaining evaluations and acceptability of energy alternatives. We consider this an important topic for future research and propose that evaluations and acceptability should be addressed as a product of contextual factors and general psychological factors, as well as the interactions between these two factors (see Fig. 2). While general psychological factors, particularly values, are likely to affect evaluations and acceptability of many different energy alternatives, the strength of the effects of values and the processes through which they influence evaluations and acceptability might differ depending on the unique characteristics of each energy alternative (which is likely to depend on the contextual factors). For example, would values exert their influence on evaluations and acceptability of energy alternatives when severe contextual barriers for acceptability are present (e.g., unaffordable price, hazardous pollution levels)? Comparing to what extent and through which processes factors (including values) predict evaluations and acceptability of different energy alternatives can lead to a more comprehensive understanding of how contextual and general psychological factors interact when shaping evaluations and acceptability of energy alternatives. That can help to assess what type of intervention (i.e., targeting contextual or general psychological factors) would be most effective for securing public acceptability (see Section 6).

Another important research question revolves around the relationship between evaluations of energy alternatives and acceptability ratings of these alternatives, which so far has been mostly studied in one direction, namely from evaluations to acceptability (see the solid line in Fig. 2). It is typically assumed that people hold certain evaluations of costs and benefits of energy alternatives and these evaluations, in turn, guide their acceptability ratings. However, taken general psychological factors, and particularly individual values, into account, we suggest that evaluations of some costs and benefits could be the result rather than the cause of value-driven acceptability ratings. More specifically, in some cases, the effects could potentially go in the direction from acceptability to evaluations (see the dashed line in Fig. 2). We derive our reasoning from the key principles of the workings of values. Specifically, given their values, people find some costs and benefits of energy alternatives important, and evaluations of these costs and benefits are likely to "truly" guide their acceptability ratings. Other costs and benefits, however, may not be very important to people but nevertheless evaluated positively or negatively, because values make energy alternatives appear in an overly positive or a negative light. Thus, we propose that given their values, people attend to specific costs and benefits to form their acceptability ratings (hence, here evaluations guide acceptability), whereas these acceptability ratings, once formed, may colour evaluations of other costs and benefits (which implies that acceptability guides these evaluations in support of one's value-based position). Importantly, some prior studies generate initial support for this reasoning by showing that values influence acceptability of energy alternatives and evaluations of costs and benefits that may not necessarily be important in the light of one's values [20,91]. Future studies need to distinguish between evaluations of costs and benefits that are important for one's values and hence may "truly" guide acceptability, and evaluations of costs and benefits that are not important for one's values that may be coloured by value-based acceptability ratings.

Additional support for the reasoning that acceptability might guide evaluations of costs and benefits comes from research on trust. Trust was found to make energy alternatives appear in an overly positive or a negative light [25,80,81], which could suggest, following our reasoning above, that evaluations of some costs and benefits could be a result of trust-based acceptability ratings. At the same time, however, people could potentially derive their trust evaluations from their evaluations and acceptability of energy alternatives, which would make trust itself a result rather than a cause of evaluations and acceptability [70,83]. Future studies are needed to clarify which route is more likely under which conditions. In general, the notion that acceptability may (also) be a cause rather than a consequence of evaluations of energy alternatives encourage to revisit the deeply embedded assumption about the one-way nature of this relationship (i.e., from evaluations to acceptability). The commonly studied correlations between these two variables can possibly be (re)interpreted as a relationship that may go both directions, and the cause and effect relationships can be further tested in experimental studies.

To sum up, the theoretical and empirical research so far sketches a conceptual framework to explain evaluations and acceptability of energy alternatives, but future studies are needed to further develop and test this framework. An important task for future research is to integrate the existing knowledge into comprehensive theories explaining why people hold certain evaluations and acceptability ratings of energy alternatives, and to systematically test these theories by adopting a range of different research methods. We propose that instead of developing specific models with different factors to explain evaluations and acceptability of different energy alternatives, it is important to study whether common factors from the general conceptual framework are indeed relevant for different types of acceptability of a wide range of energy alternatives. We identified new relationships in the conceptual framework that, although having received some initial empirical evidence, have not been systematically addressed in the literature so far. We expect that this review paper provides a good basis for future studies to address these new questions, thereby contributing to a more comprehensive and accurate understanding of evaluations and acceptability of energy alternatives.

6. Policy implications

The conceptual framework proposed in this review paper aims to explain evaluations and acceptability of many different energy alternatives. Employing the framework may provide important practical implications for practitioners and policy makers to facilitate sustainable energy transitions. Below, we first describe

how not taking into account various contextual and general psychological factors is likely to lead to ineffective intervention strategies. Next, we provide suggestions for how to target contextual and general psychological factors in interventions aiming to secure public support for sustainable energy transitions.

Mutual influences of contextual and general psychological factors are rarely considered in practice, as the focus lies on a limited number of factors that are presumed to be dominant in evaluations and acceptability of energy alternatives. For example, practitioners and policy makers typically assume that financial arguments are most important to people, and hence they use exclusively these arguments to promote energy alternatives (e.g., emphasising monetary pay-offs in the long run as the key reason to adopt renewable energy sources). This review demonstrates, however, that people may accept energy alternatives even if that implies higher costs to them, provided that the energy alternatives have desired elements, for instance low CO_2 emissions. Thus, people may find environmental consequences of energy alternatives important, or even more important, than monetary costs (provided that costs are not extremely high making energy alternatives unaffordable), and therefore financial arguments may not be the key strategy in promoting acceptability. In fact, there is growing evidence to suggest that environmental arguments may even outperform financial arguments in encouraging sustainable choices [107,108].

It is often assumed in practice that people will change their evaluations and acceptability ratings if they receive more information about energy alternatives. Yet, the findings reported here suggest that information strategies may not always yield the intended effects on acceptability. Although information provision can extend people's knowledge or correct their misperceptions (if present) of certain costs and benefits of energy alternatives, it depends on contextual and general psychological factors how this knowledge will eventually influence evaluations and acceptability ratings. For example, contextual factors other than those addressed in information campaigns may be more important to people and drive acceptability irrespective of the given information. In that case, information about the key contextual factors might be more relevant or, in some cases, actual contextual changes may be necessary to sustain acceptability [39,40]. Besides, trust in information sources is important. People will particularly integrate information in their evaluations and acceptability ratings if they trust the information source, whereas they are likely to disregard information coming from sources that they do not trust. In addition, the effects of information strategies are likely to depend on people's values, which define how important certain information is to people. Information that does not resonate with one's important values will most likely not motivate people to change their evaluations and acceptability judgements. Thus, the effectiveness of information strategies could potentially be improved by tailoring information to people's important values [109], or by changing the influence of values on evaluations, as we will explain later in this section. Interestingly, it has been found that people particularly attend to information that supports their prior judgements, whereas they disregard information that speaks against these judgements, a phenomenon known as motivated cognition [110,111]. We argue that people may build their initial judgements of energy alternatives on the basis of their values and, consequently, evaluate information according to how well it "fits" their value-based judgements. For example, people with strong biospheric values may disregard the argument that nuclear energy has low CO_2 emissions and is therefore (relatively) sustainable if they have already judged nuclear energy as not sustainable, for instance because of pollution in case of accidents [20]. It is therefore important to know which characteristics of energy alternatives "truly" guide acceptability ratings and address particularly these characteristics in information campaigns. Below, we elaborate on how contextual and general psychological factors can be addressed in intervention strategies.

One way to secure public acceptability is by changing the actual costs and benefits via contextual changes. In pursuit of sustainable energy transitions, this would mean reducing the costs and increasing the benefits of sustainable energy alternatives and, in contrast, increasing the costs and reducing the benefits of non-sustainable energy alternatives. Examples of such contextual changes include, among others, changes in safety measures, energy prices, and energy technology. We argue that such contextual changes are particularly important when severe contextual barriers for acceptability exist (e.g., unaffordable energy price), which may overrule the influence of general psychological factors on evaluations and acceptability [7,8]. For example, even people with strong biospheric values may not adopt sustainable energy alternatives if these alternatives imply much higher costs to them than non-sustainable alternatives. Indeed, the perceived moral obligation to use "green" energy was more predictive of the intention to use "green" energy in the Netherlands, where the price difference between "green" and "non-green" energy is relatively small, whereas it was less predictive in other countries, where the price difference is considerably large [112]. Reducing the price difference could therefore increase the possibility that people who strongly endorse biospheric values and therefore feel morally obliged to adopt "green" energy will actually do so.

Changing contextual factors might not always be possible or can be highly costly. Furthermore, our review clearly demonstrates that the way people perceive costs and benefits depends not only on contextual factors but also on general psychological factors. Therefore, addressing general psychological factors is an additional way to influence evaluations and acceptability of energy alternatives. For example, an important condition for sustainable energy transitions is that people trust the involved parties and the proposed sustainable energy alternatives. However, recent findings indicate that people put relatively little trust in key actors in sustainable energy transitions, namely energy companies and the national (UK) government, as people do not think they are honest, open, and fair [10,13]. How can these perceptions be changed in order to promote sustainable energy transitions? A strategy frequently used by practitioners and policy makers is to try and show to people that the different parties have enough knowledge, skills, and expertise to carry out their responsibilities. The literature suggests, however, that information about values of these parties affects trust more strongly than information about their skills and competencies [84,86]. Low trust in energy companies and the government could be (partly) due to the fact that people see these parties as only interested in making profit and not taking people's well-being and environmental quality into consideration. A relevant study on trust in parties involved in CCS technology found that inferred organisation-serving motives (e.g., economic gain) accounted for relatively low trust in industrial organisations, whereas inferred public-serving motives (e.g., concern with the environment) accounted for relatively high trust in NGOs among Dutch citizens [113]. Interestingly, the same study found that respondents found it dishonest when an industrial organisation simply communicated public-serving motives, which instigated even less trust than when the organisation communicated organisation-serving motives. Only when the organisation communicating public-serving motives also acknowledged its self-serving motives, trust could be preserved [113]. Thus, it is essential that parties are honest and transparent about all their important values. Possibly, acting upon societal values, rather than merely communicating these values, could help the industry and governments to (re)gain public trust, for example by investing in community or environmental funds, establishing social facilities, listening

to people's opinion and taking it into consideration in decision making [113]. This proposition needs to be tested in future (experimental) studies.

Based on our review, we propose that, if there are no severe contextual barriers, evaluations and acceptability of energy alternatives can be (further) influenced by targeting individual values. Biospheric values in particular can provide a strong basis for promoting sustainable energy transitions, as people with strong biospheric values may accept sustainable energy alternatives even if that implies some costs to them personally. It is therefore surprising that the possibility of strengthening the influence of biospheric values on evaluations and acceptability has been largely neglected in the literature and in practice on sustainable energy transitions. Below, we suggest three main routes to increase the influence of biospheric values on evaluations and acceptability of sustainable energy alternatives (cf. [8]).

One possible route is via strengthening biospheric values, since, as noted above, it seems that the relative strength of values can change in time. Strengthening biospheric values might require systematic long-term interventions, such as incorporating sustainability subjects in general education programmes. Communicating sound scientific evidence about environmental problems and their detrimental effects for our way of living in the media and public debate, as well as looking for and discussing the potential solutions to these problems could strengthen biospheric values in today's society and among future generations [114].

Another (parallel) route is to enable people to act upon their biospheric values. This implies reducing very high costs and increasing benefits of sustainable energy alternatives, in order to remove severe contextual barriers for acceptability. However, reducing the (individual) costs of energy alternatives might not always be possible and, notably, focusing particularly on costs might activate egoistic and hedonic values and increase their influence on people's evaluations and acceptability ratings. This might be counterproductive, as egoistic and hedonic values are not likely to provide a reliable basis for acceptability of sustainable energy alternatives [8]. Specifically, if driven primarily by egoistic and hedonic interests, people will engage in sustainable energy transitions only if (or as long as) that is beneficial for them, whereas they will withdraw if (or as soon as) individual benefits decrease or individual costs increase.

The third (parallel) possibility is to activate biospheric values. People are more likely to act upon their (biospheric) values when these values are activated in a given situation [87,115]. Various situational cues could activate values, for example providing reasons for values [116] or value-signalling behaviours of others [117,118]. Energy policies could also serve as cues activating or deactivating certain values. Focusing exclusively on egoistic arguments (e.g., profit, price) in policy making might activate people's egoistic and hedonic values, therefore increasing the influence of these values on evaluations and acceptability of energy alternatives [119]. To prevent that from happening (since egoistic and hedonic values do not create a reliable basis for acceptability of sustainable energy transitions), egoistic arguments should not be the only or dominant ones when promoting sustainable energy alternatives. Instead, sustainable energy transitions should be linked to higher-order societal and environmental goals, in order to (further) strengthen the influence of biospheric values on evaluations and acceptability, and therefore creating a more reliable public support for sustainable energy transitions.

To sum up, public support for sustainable energy transitions can be enhanced by changing the actual costs and benefits of energy alternatives (i.e., contextual changes) and/or by addressing general psychological factors that shape how these costs and benefits are perceived and evaluated. A particularly promising strategy in this respect is increasing the influence of biospheric values on evaluations and acceptability of energy alternatives, by strengthening these values in a long term, enabling people to act upon these values, and activating these values when promoting sustainable energy alternatives. This can preserve public support for sustainable energy alternatives even if that implies costs to people.

7. Conclusions

We reviewed numerous studies in order to derive a conceptual framework that explains evaluations and acceptability of energy alternatives. The current framework contributes to the literature by integrating both contextual factors and general psychological factors. While the context of energy alternatives implies certain costs and benefits to people, general psychological factors may influence how people evaluate these costs and benefits and how they integrate these evaluations in their acceptability ratings. New to the literature, we proposed a general conceptual framework that is not bound to a specific energy alternative but aims to explain evaluations and acceptability of many different energy alternatives, including acceptability on a general as well as community level. Across studies, we found evidence to suggest that particularly individual values may have an overarching effect on evaluations and acceptability of a wide range of energy alternatives, by guiding the importance of various costs and benefits to people. We developed a research agenda with two major themes (Section 5). First, we listed key research questions to be addressed to further test the conceptual framework. More specifically, we proposed the need to test the relationships between key variables in the conceptual framework across different energy alternatives and different types of acceptability, thereby employing different research methods as to cross-validate findings and to test the generalisability of results. Second, we introduced new relationships in the conceptual framework that need to be tested in future research. More specifically, we indicated that it is important to study the effects of interactions between contextual and general psychological factors on evaluations and acceptability of energy alternatives, and to test the direction of the causal relationships between evaluations and acceptability. This will result in a more comprehensive and accurate understanding of factors that shape evaluations and acceptability of energy alternatives, which may yield important policy implications. We stressed how taking contextual and general psychological factors into account can help to develop effective intervention and communication strategies to enhance sustainable energy transitions.

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Table A1
The reviewed studies and the factors from the proposed conceptual framework that were addressed in these studies[a].

Study details					Factors in the conceptual framework			
Authors (year)	**Country**	**Sample size (analysed)**	**Energy alternatives**	**Qualitative or quantitative study**	**Perceived collective and individual costs and benefits**	**Perceived fairness**	**Contextual factors**	**General psychological factors**
Aldy et al. (2012) [51]	US	983	Renewable energy sources, renewables with natural gas, renewables with nuclear energy	Quantitative	–	–	+ Price, comparison of acceptability of renewables alone, renewables and natural gas, and renewables and nuclear	–
Alhakami and Slovic (1994) [68]	US	100	Renewable energy sources, fossil fuels, nuclear energy (also other activities and technology not related to energy alternatives)	Quantitative	+ (Reflected in the measures of the perceived risks and perceived benefits for the US society)	–	–	–
Arkesteijn and Oerlemans (2005) [15]	The Netherlands	115	Green electricity	Quantitative	+	–	–	+ Trust, perceived own responsibility for the environment
Bang et al. (2000) [101]	US	347	Renewable energy	Quantitative (preparation of the survey also included interviews)	+	–	–	+ Environmental concern
Bickerstaff et al. (2008) [41]	UK	Survey: 1547, focus groups: 32	Nuclear energy	Qualitative and quantitative	+	+	+ Framing nuclear power as a solution to climate change	+ Trust
Bidwell (2013) [91]	US	375	Wind energy (particularly wind farms), support for a coal-fired power plant and nuclear plant was measured but not discussed	Quantitative	+	+	–	+ Place-attachment and place-identity, values, environmental beliefs
Blauw Research, commis-sioned by GasTerra and Quintel (2011) [43]	The Netherlands	Survey: 2174, stakeholder interviews: 14	Renewable energy sources, fossil fuels, nuclear energy	Qualitative and quantitative	+	–	–	–
Boudet et al. (2014) [44]	US	1061	Hydraulic fracturing for oil and gas	Quantitative	+ (Respondents reported the first things that come to mind when thinking of "fracking")	–	+ Spatial proximity	+ Worldviews
Bronfman et al. (2012) [24]	Chile	243	Renewable energy sources, fossil fuels, nuclear energy	Quantitative	+	–	–	+ Trust
Butler et al. (2011) [47]	Diverse (literature review)	n.a.	Nuclear energy	Literature review and authors' interpretation of the	+ (Key focus on perceived collective rather than individual costs and benefits)	+	+ Framing nuclear power as a solution to climate change, safety of operation, spatial proximity, fair procedures, compensation strategies	+ Trust

				development of nuclear energy				
Butler et al. (2013) [10] (see also [13])	UK	68	Renewable energy sources, fossil fuels, nuclear energy, CCS	Qualitative	+	+	–	+ Trust, values, place-attachment and place-identity[b]
Corner et al. (2011) [14]	UK	1822	Nuclear energy	Quantitative	–	–	+ Framing nuclear power as a solution to climate change and energy security problems	+ Values, concern with climate change, concern with energy security
Culley et al. (2011) [11]	US	277	Solar, wind, coal, and nuclear energy	Quantitative	+	+	–	+ Environmental worldviews
Devine-Wright (2003) [12]	Austria, Greece, Hungary, Portugal, Romania, Slovakia, UK	1866	Renewable energy sources, fossil fuels, nuclear energy	Quantitative	+	–	+ Evaluations and acceptability of energy alternatives compared across countries	–
Devine-Wright (2005) [32]	UK	167	Local renewable energy projects (particularly a wind farm project)	Quantitative	–	+	+ Fair procedures, evaluations and acceptability compared before and after participation in the project	–
Devine-Wright (2005) [34]	Diverse (literature review)	n.a.	Wind energy	Literature review	+	+	+ Physical characteristics, spatial proximity, fair procedures, acceptability and evaluations over time	+ Place-attachment and place-identity, trust
Devine-Wright (2009) [58]	Diverse (literature review)	n.a.	Renewable energy sources (particularly facility siting)	Literature review	+ (Key focus on perceived costs and risks to a community and place)	+	+ Spatial proximity	+ Place-attachment and place-identity, trust
Devine-Wright (2011) [73]	Ireland	Survey: 271 (focus groups with $n=32$ were not reported in this paper)	Tidal energy converter	Quantitative (focus groups were not reported in this paper)	–	–	+ Evaluations and acceptability compared across two villages	+ Place-attachment and place-identity
Devine-Wright and Howes (2010) [74]	UK	Focus groups:33, survey: 457 (interviews were also carried out but sample size and results are not reported in this paper)	Wind energy (particularly an offshore wind farm)	Qualitative and quantitative	+	–	+ Evaluations and acceptability compared across two towns	+ Place-attachment and place-identity, trust
De Groot and Steg (2010) [19] (see also [20])	The Netherlands	123	Nuclear energy	Quantitative	+	–	–	–
De Groot and Steg (2011) [26]	Diverse (literature review)	n.a.	Radioactive waste disposal technology, CCS	Literature review	+	+	+ Spatial proximity	+ Trust, values, worldviews
De Groot et al. (2013) [20] (see also [19])	The Netherlands	123	Nuclear energy	Quantitative	+	–	–	+ Values
Flynn et al. (1992) [27]	US	500	Nuclear waste repository	Quantitative	+	–	–	+ Trust
Frey et al. (1996) [60]	Switzerland	305	Nuclear waste repository	Qualitative	+	+	+ Compensation strategies	–
Gowda and Easterling (2000) [37]	US (Native America)	Not specified (the authors mention interviews)	Nuclear waste repository	Authors' interpretation with references to interviews	–	+	+ Compensation strategies, fair procedures	–
Groothuis et al. (2008) [64]	US (the mountains	389	Wind energy (particularly windmills)	Quantitative	+	–	+ Compensation strategies	–

Table A1 (*continued*)

Study details					Factors in the conceptual framework			
Authors (year)	**Country**	**Sample size (analysed)**	**Energy alternatives**	**Qualitative or quantitative study**	**Perceived collective and individual costs and benefits**	**Perceived fairness**	**Contextual factors**	**General psychological factors**
	of North Carolina)							
Gross (2007) [33]	Australia	12	Wind energy	Qualitative	–	+	–	–
Halder et al. (2012) [16]	Finland, Slovakia, Taiwan, Turkey	1903	Bioenergy	Quantitative	+ (Key focus on perceived collective costs and benefits)	–	+ Evaluations and acceptability of energy alternatives compared across countries	–
Hocke and Renn (2009) [36]	Germany	n.a.	Nuclear waste repository	Authors' interpretation of the development of nuclear waste repository siting	–	–	+ Fair procedures	–
Huijts et al. (2013) [67]	The Netherlands	Group 1 with information about hydrogen: 800, group 2 without information about hydrogen (to validate the results): 414	Hydrogen refueling facility	Quantitative	+ (Reflected in the personal norm to act and attitudes towards acting in favour or against a hydrogen refuelling facility)	–	–	–
Huijts et al. (2007) [57]	The Netherlands	Interviews with professional actors: 8 (results extended by analysis of reports of three multiple-actor working groups), survey: 103	CCS	Qualitative and quantitative	+	–	+ Spatial proximity	+ Trust
Huijts et al. (2012) [5]	Diverse (literature review)	n.a.	Diverse (literature review with a key focus on sustainable energy technology)	Literature review	+	+	–	+ Trust
Jenkins-Smith and Kunreuther (2001) [63]	US	1234	Nuclear waste repository (also other hazardous facilities not related to energy alternatives)	Quantitative (included experimental design)	+ (Reflected in the measures of the perceived risk and perceived need of a hazardous facility)	–	+ Compensation strategies	+ Trust
Katsuya (2001) [49]	Japan	Survey 1: 1620, Survey 2: 810	Nuclear energy	Quantitative (included a repeated measurement)	+	–	+ Safety of operation (effects of a nuclear accident in Tokai, Japan)	+ Trust
Kobus et al. (2013) [55]	The Netherlands	21	Household energy managing system for the use of renewable energy sources	Qualitative	+	–	+ Quality of energy supply/physical characteristics (effects of technology that facilitates the use of renewable energy sources in households)	+ Trust in the system
Krütli et al. (2010) [35]	Switzerland	Media analysis: 60 articles, stakeholder interviews: 5, survey: 532, interviews: 41	Nuclear waste repository	Qualitative and quantitative	+ (Collective and individual costs and benefits not explicitly distinguished)	+	+ Evaluations and acceptability compared across different municipalities and over time	+ Trust (values were included in the survey but not further discussed)
Mansfield et al. (2002) [62]	US	Survey 1: 160, Survey 2: 202; Survey 3: 265, focus groups not specified	Waste-to-energy plant producing electricity from household waste (also other public harms	Qualitative and quantitative	–	–	+ Compensation strategies	–

			not related to energy alternatives)					
McGowan and Sauter (2005) [18]	UK	n.a.	Diverse (literature review)	Literature review	+	–	+ Spatial proximity, evaluations and acceptability over time	–
Midden and Huijts (2009) [25]	The Netherlands	103	CCS	Quantitative	+	–	+ Spatial proximity	+ Trust
Montijn-Dorgelo and Midden (2008) [81]	The Netherlands	406	Hydrogen	Quantitative	+	–	–	+ Trust
Noppers et al. (2014) [28]	The Netherlands	143	Local renewable energy systems	Quantitative	+	–	–	–
Palmgren et al. (2004) [22]	US	Study 1: 18, Study 2: 126	Geological and oceanic CCS	Qualitative (Study 1) and quantitative (Study 2)	+	–	+ Evaluations and acceptability compared for geological and oceanic CCS	+ Environmental worldviews
Pedersen and Waye (2004) [56]	Sweden	351	Wind energy (particularly wind turbines)	Quantitative	+	–	+ Physical characteristics, spatial proximity (used mainly to define sound annoyance from turbines)	–
Pidgeon et al. (2008) [42] (see also [100])	UK	1491	Nuclear energy (key focus), renewable energy sources, fossil fuels	Quantitative (included experimental design)	+ (Perceived collective and individual costs and benefits are not explicitly distinguished)	–	+ Framing nuclear power as a solution to climate change	–
Prati and Zani (2012) [48]	Italy	32	Nuclear energy	Quantitative (included a repeated measurement)	+	–	+ Safety of operation (effects of the Fukushima nuclear accident)	+ Trust, values, environmental beliefs (all were studied as dependent variables susceptible to the Fukushima accident, but not included as independent variables to explain evaluations and acceptability)
Siegrist and Cvetkovich (2000) [80]	US	91	Nuclear energy, hydroelectric power (also other activities and technology not related to energy alternatives)	Quantitative	+ (Reflected in the measures of the perceived risks and perceived benefits for the US society)	–	–	+ Trust
Siegrist et al. (2000) [86]	Switzerland	261 ($n=250$ for nuclear energy)	Nuclear energy (also other activities and technology not related to energy alternatives)	Quantitative	+	–	–	+ Trust
Siegrist and Visschers (2012) [50]	Switzerland	463	Nuclear energy	Quantitative (included a repeated measurement)	–	–	+ Safety of operation (effects of the Fukushima nuclear accident)	–
Sjoberg (2001) [82]	Sweden	Study 1: 444 citizens and 58 experts; Study 2: approx. 532 citizens and approx. 346 politicians[c]	Nuclear energy and nuclear waste (also other activities and technology not related to energy alternatives)	Quantitative	+ (Key focus on perceived risks)	–	–	+ Trust
Spence et al. (2010) [100] (see also [42])	UK	1491	Fossil fuels, renewable energy sources, nuclear energy	Quantitative	+ (Key focus on perceived collective costs and benefits)	–	–	+ Environmental concern, concern about climate change
Ter Mors et al. (2012) [59]	Diverse (literature review)	n.a.	CCS	Literature review	+ (Main focus on perceived collective risks)	+	+ Compensation strategies, fair procedures (not present in the literature analysis but	+ Trust (not present in the literature analysis but introduced by the authors as an important factor)

Table A1 (*continued*)

Study details					Factors in the conceptual framework			
Authors (year)	**Country**	**Sample size (analysed)**	**Energy alternatives**	**Qualitative or quantitative study**	**Perceived collective and individual costs and benefits**	**Perceived fairness**	**Contextual factors**	**General psychological factors**
							introduced by the authors as an important factor)	
Terwel and Daamen (2012) [23]	The Netherlands	175	CCS	Quantitative (included quasi-experimental design)	+	–	+ Spatial proximity	+ Trust, concern about climate change
Terwel et al. (2009) [113]	The Netherlands	Study 1: 73, Study 2: 75	CCS	Quantitative (included experimental design)	+	–	+ (The effects of information about involved parties on evaluations and acceptability)	+ Trust
Terwel et al. (2010) [66]	The Netherlands	Study 1: 40, Study 2: 80, Study 3: 83	CCS	Quantitative (included experimental design)	–	+	+ Fair procedures	+ Trust
Terwel et al. (2012) [38]	The Netherlands	811	CCS	Quantitative	+	+	– (The CCS project is discussed in detail but project characteristics are not systematically linked to evaluations and acceptability)	+ Trust
Visschers et al. (2011) [21]	Switzerland	967	Nuclear energy	Quantitative	+	–	–	+ Trust
Vorkinn and Riese (2001) [75]	Norway	305	Hydropower	Quantitative	–	–	–	+ Place-attachment and place-identity
Walker and Devine-Wright (2008) [65]	UK	n.a. (overview of multiple studies)	Renewable energy sources	Overview of multiple studies	–	+	+ Fair procedures	–
Walker et al. (2010) [31]	UK	Stakeholder interviews: 56, survey: 208	Local renewable energy projects	Qualitative and quantitative	+ (Mentioned in the interviews)	+	+ Fair procedures, evaluations and acceptability compared for several renewable energy projects	+ Social identification with the community, trust, (environmental beliefs and worldviews included in the survey but not discussed)
Whitfield et al. (2009) [79]	US	380	Nuclear energy	Quantitative	+ (Main focus on collective risks)	–	–	+ Trust, values, environmental beliefs
Wolsink (2007) [17]	The Netherlands	Multiple studies with different samples	Wind energy	Quantitative (extended analysis of multiple studies)	+	+	+ Physical characteristics, location and landscape type, the stage of project development	+ Environmental concern
Wolsink (2012) [52]	Diverse (literature review)	n.a.	Distributed generation electricity grids for the use of renewable energy sources	Literature review	–	–	+ Price, quality of energy supply, physical characteristics, spatial proximity, compensation strategies, fair procedures	+ Place-attachment and place-identity, trust
Von Borgstede et al. (2013) [102]	Sweden	Survey 1: 74, Survey 2: 615	Renewable energy sources, fossil fuels, nuclear energy, CCS (also other tax investment	Quantitative	–	–	–	+ Attitudes towards global warming and climate change

			areas not related to energy alternatives)					
Wüstenhagen et al. (2007) [1]	Diverse (literature review)	n.a.	Renewable energy sources (key focus on wind energy), CCS	Literature review from view of a conceptual framework	–	+	+ Price (we derive this from the discussion on market acceptance), quality of energy supply, physical characteristics, spatial proximity, fair procedures, changes in evaluations and acceptability over time, location and landscape type	+ Place-attachment and place-identity, trust

Note: Only factors from the proposed conceptual model are specified.

We categorised general antecedents such as environmental concern, environmental worldviews and beliefs, and concern about climate change as general psychological factors, because they reflect the extent to which people value nature and the environment, and are thus comparable to (and related to [120]) biospheric values. Similarly, we categorised concern about energy security (related to egoistic values) as a general psychological factor in the table. However, we stress that it is important to conceptually differentiate concern with specific issues and values, as values operate on a more general level and reflect a wider diversity of motivations, see [95].

We did not categorise studies that compared evaluations and acceptability of different energy alternatives as studies of contextual factors, because the energy alternatives included differed on a wide range of characteristics, making it impossible to conclude which specific contextual factors caused variance in evaluations and acceptability. We only refer to place of residence as a contextual factor when the (perceived) costs and benefits of energy alternatives were likely to systematically differ across the different places of residence.

Articles that were included in this review due to their focus on relevant topics (e.g., acceptability of energy policies [53], persuasive technology [54], trust dimensions and factors that influence trust [84,113]) but are not directly related to evaluations and acceptability of specific energy alternatives are not listed here.

[a] See a note at the end of the table for additional criteria for reporting the studies.

[b] The authors did not explicitly use the label place-attachment and place-identity, but they discussed people's material relations with place, perceived associations with socio-cultural and political issues, and privacy at home. Given these indicators, we consider that this study (partly) addressed the factor place-attachment and place-identity. The same applies to the study by Parkhill et al. [13].

[c] We estimated sample size in Study 2 based on the reported response rate, however without knowing the number of excluded responses, we cannot provide the exact estimation.

Appendix A

See appendix Table A1.

References

[1] Wüstenhagen R, Wolsink M, Bürer MJ. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Policy 2007;35:2683–91.

[2] Abrahamse W, Steg L, Vlek C, Rothengatter T. A review of intervention studies aimed at household energy conservation. J Environ Psychol 2005;25:273–91.

[3] Gatersleben B, Vlek C. Household consumption, quality-of-life and environmental impacts: a psychological perspective and empirical study. In: Noorman KJ, Uiterkamp TS, editors. Green households? Domestic consumers, environment, and sustainability London: Earthscan; 1998. p. 141–79.

[4] Wolsink M. Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. Renew Energy 2000;21:49–64.

[5] Huijts NMA, Molin EJE, Steg L. Psychological factors influencing sustainable energy technology acceptance: a review-based comprehensive framework. Renew Sustain Energy Rev 2012;16:525–31.

[6] Lindenberg S, Steg L. Normative, gain and hedonic goal frames guiding environmental behavior. J Social Issues 2007;63:117–37.

[7] Lindenberg S, Steg L. Goal-framing theory and norm-guided environmental behavior. In: Van Trijp HCM, editor. Encouraging sustainable behavior. New York: Psychology Press; 2014. p. 37–54.

[8] Steg L, Bolderdijk JW, Keizer K, Perlaviciute G. An integrated framework for encouraging pro-environmental behaviour: The role of values, situational factors and goals. J Environ Psychol 2014;38:104–15.

[9] Schuitema G, Bergstad CJ. Acceptability of environmental policies. In: Steg L, Van den Berg AE, De Groot JIM, editors. Environmental psychology: an introduction. West Sussex, UK: John Wiley & Sons, Ltd; 2012. p. 256–66.

[10] Butler C, Parkhill KA, Pidgeon N. Deliberating energy transitions in the UK—transforming the UK energy system: public values, attitudes and acceptability. London: UKERC; 2013.

[11] Culley MR, Carton AD, Weaver SR, Ogley-Oliver E. Street, Sun, wind, rock and metal: attitudes toward renewable and non-renewable energy sources in the context of climate change and current energy debates. Curr Psychol 2011;30:215–33.

[12] P. Devine-Wright, A cross-national, comparative analysis of public understanding of, and attitudes towards nuclear, renewable and fossil-fuel energy sources. In: Craig T, editor. Proceedings of the third conference of the UK network environmental psychology in the UK—crossing boundaries: the value of interdisciplinary research; 2003. p. 160–73.

[13] Parkhill KA, Demski C, Butler C, Spence A, Pidgeon N. Transforming the UK energy system: public values, attitudes and acceptability—synthesis report. London: UKERC; 2013.

[14] Corner A, Venables D, Spence A, Poortinga W, Demski C, Pidgeon N. Nuclear power, climate change and energy security: exploring British public attitudes. Energy Policy 2011;39:4823–33.

[15] Arkesteijn K, Oerlemans L. The early adoption of green power by Dutch households: an empirical exploration of factors influencing the early adoption of green electricity for domestic purposes. Energy Policy 2005;33:183–96.

[16] Halder P, Prokop P, Chang CY, Usak M, Pietarinen J, Havu-Nuutinen S, et al. International survey on bioenergy knowledge, perceptions, and attitudes among young citizens. BioEnergy Res 2012;5:247–61.

[17] Wolsink M. Wind power implementation: the nature of public attitudes: equity and fairness instead of 'backyard motives'. Renew Sustain Energy Rev 2007;11:1188–207.

[18] McGowan F, Sauter R. Public opinion on energy research: a desk study for the research councils. Brighton: University of Sussex; 2005.

[19] De Groot JIM, Steg L. Morality and nuclear energy: perceptions of risks and benefits, personal norms, and willingness to take action related to nuclear energy. Risk Anal 2010;30:1363–73.

[20] De Groot JIM, Steg L, Poortinga W. Values, perceived risks and benefits, and acceptability of nuclear energy. Risk Anal 2013;33:307–17.

[21] Visschers VHM, Keller C, Siegrist M. Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: investigating an explanatory model. Energy Policy 2011;39:3621–9.

[22] Palmgren CR, Morgan MG, De Bruin WB, Keith DW. Initial public perceptions of deep geological and oceanic disposal of carbon dioxide. Environ Sci Technol 2004;38:6441–50.

[23] Terwel BW, Daamen DDL. Initial public reactions to carbon capture and storage (CCS): differentiating general and local views. Clim Policy 2012;12:288–300.

[24] Bronfman NC, Jiménez RB, Arévalo PC, Cifuentes LA. Understanding social acceptance of electricity generation sources. Energy Policy 2012;46:246–52.

[25] Midden CJH, Huijts NMA. The role of trust in the affective evaluation of novel risks: the case of CO_2 storage. Risk Anal 2009;29:743–51.

[26] De Groot JIM, Steg L. Psychological perspectives on the geological disposal of radioactive waste and carbon dioxide. In: Toth FL, editor. Geological disposal of carbon dioxide and radioactive waste: a comparative assessment, vol. 44. Dordrecht, London, Heidelberg, New York: Springer; 2011. p. 339–63.

[27] Flynn J, Burns W, Mertz CK, Slovic P. Trust as a determinant of opposition to a high-level radioactive waste repository: analysis of a structural model. Risk Anal. 1992;12:417–29.
[28] Noppers E, Keizer K, Bolderdijk JW, Steg L. The adoption of sustainable innovations: driven by symbolic and environmental motives. Global Environ Chang 2014;25:52–62.
[29] Tyler TR. Social justice: outcome and procedure. Int J Psychol 2000;35:117–25.
[30] Sjoberg L, Drottz-Sjoberg BM. Fairness, risk and risk tolerance in the siting of a nuclear waste repository. J Risk Res 2001;4:75–101.
[31] Walker G, Devine-Wright P, Hunter S, High H, Evans B. Trust and community: exploring the meanings, contexts and dynamics of community renewable energy. Energy Policy 2010;38:2655–63.
[32] Devine-Wright P. Local aspects of UK renewable energy development: exploring public beliefs and policy implications. Local Environ 2005;10:57–69.
[33] Gross C. Community perspectives of wind energy in Australia: the application of a justice and community fairness framework to increase social acceptance. Energy Policy 2007;35:2727–36.
[34] Devine-Wright P. Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. Wind Energy 2005;8:125–39.
[35] Krütli P, Flüeler T, Stauffacher M, Wiek A, Scholz RW. Technical safety vs. public involvement? A case study on the unrealized project for the disposal of nuclear waste at Wellenberg (Switzerland) J Integr Environ Sci 2010;7:229–44.
[36] Hocke P, Renn O. Concerned public and the paralysis of decision-making: nuclear waste management policy in Germany. J Risk Res 2009;12:921–40.
[37] Gowda MVR, Easterling D. Voluntary siting and equity: the MRS facility experience in Native America. Risk Anal 2000;20:917–30.
[38] Terwel BW, Ter Mors E, Daamen DDL. It's not only about safety: beliefs and attitudes of 811 local residents regarding a CCS project in Barendrecht. Int J Green Gas Con 2012;9:41–51.
[39] McAllister J, Van Praag E, Van Soest JP. Earth fever: living consciously with climate change. New York, NY: Cosimo, Inc; 2010.
[40] Thøgersen J. How may consumer policy empower consumers for sustainable lifestyles? J Consum Policy 2005;28:143–77.
[41] Bickerstaff K, Lorenzoni I, Pidgeon NF, Poortinga W, Simmons P. Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste. Public Underst Sci 2008;17:145–69.
[42] Pidgeon NF, Lorenzoni I, Poortinga W. Climate change or nuclear power—no thanks! A quantitative study of public perceptions and risk framing in Britain. Global Environ Change 2008;18:69–85.
[43] Blauw Research, commissioned by GasTerra and Quintel. Bewustwording energietransitie. Onderzoek naar kennis en imago omtrent energietransitie [Awareness energy transition. Research on knowledge and image of energy transition]. Research report B13126-2; 2011.
[44] Boudet H, Clarke C, Bugden D, Maibach E, Roser-Renouf C, Leiserowitz A. "Fracking" controversy and communication: using national survey data to understand public perceptions of hydraulic fracturing. Energy Policy 2014;65:57–67.
[45] Editorial. Fracking fracas. Nature Clim Change 2013;3:429.
[46] Shackley S, McLachlan C, Gough C. The public perception of carbon dioxide capture and storage in the UK: results from focus groups and a survey. Clim Policy 2004;4:377–98.
[47] Butler C, Parkhill KA, Pidgeon NF. Nuclear power after Japan: the social dimensions. Environ: Sci Policy Sustain Dev 2011;53:3–14.
[48] Prati G, Zani B. The effect of the Fukushima nuclear accident on risk perception, antinuclear behavioral intentions, attitude, trust, environmental beliefs, and values. Environ Behav 2012;45:782–98.
[49] Katsuya T. Public response to the Tokai nuclear accident. Risk Anal 2001;21:1039–46.
[50] Siegrist M, Visschers VHM. Acceptance of nuclear power: the Fukushima effect. Energy Policy 2012;59:112–9.
[51] Aldy JE, Kotchen MJ, Leiserowitz AA. Willingness to pay and political support for a US national clean energy standard. Nat Clim Change 2012;2:596–9.
[52] Wolsink M. The research agenda on social acceptance of distributed generation in smart grids: renewable as common pool resources. Renew Sustain Energy Rev 2012;16:822–35.
[53] Steg L, Dreijerink L, Abrahamse W. Why are energy policies acceptable and effective? Environ Behav 2006;38:92–111.
[54] Midden C, Ham J. Persuasive technology to promote pro-environmental behaviour. In: Steg L, Van den Berg AE, De Groot JIM, editors. Environmental psychology: an introduction. West Sussex, UK: John Wiley & Sons, Ltd.; 2012. p. 243–54.
[55] Kobus CBA, Mugge R, Schoormans JPL. Washing when the sun is shining! How users interact with a household energy management system. Ergonomics 2013;56:451–62.
[56] Pedersen E, Waye KP. Perception and annoyance due to wind turbine noise—a dose–response relationship. J Acoust Soc Am 2004;116:3460–70.
[57] Huijts NMA, Midden CJH, Meijnders AL. Social acceptance of carbon dioxide storage. Energy Policy 2007;35:2780–9.
[58] Devine-Wright P. Rethinking NIMBYism: the role of place attachment and place identity in explaining place-protective action. J Commun Appl Soc Psychol 2009;19:426–41.
[59] Ter Mors E, Terwel BW, Daamen DDL. The potential of host community compensation in facility siting. Int J Greenhouse Gas Control 2012;11S: S130–S138.
[60] Frey BS, Oberholzer-Gee F, Eichenberger R. The old lady visits your backyard: a tale of morals and markets. J Polit Econ 1996;104:1297–313.
[61] Bohm G, Tanner C. Environmental risk perception. In: Steg L, Van den Berg AE, De Groot JIM, editors. Environmental psychology: an introduction. West Sussex, UK: John Wiley & Sons, Ltd.; 2012. p. 15–25.
[62] Mansfield C, Van Houtven GL, Huber J. Compensating for public harms: why public goods are preferred to money. Land Econ 2002;78:368–89.
[63] Jenkins-Smith H, Kunreuther H. Mitigation and benefits measures as policy tools for siting potentially hazardous facilities: determinants of effectiveness and appropriateness. Risk Anal 2001;21:371–82.
[64] Groothuis PA, Groothuis JD, Whitehead JC. Green vs. green: measuring the compensation required to site electrical generation windmills in a viewshed. Energy Policy 2008;36:1545–50.
[65] Walker G, Devine-Wright P. Community renewable energy: what should it mean? Energy Policy 2008;36:497–500.
[66] Terwel BW, Harinck F, Ellemers N, Daamen DDL. Voice in political decision-making: the effect of group voice on perceived trustworthiness of decision makers and subsequent acceptance of decisions. J Exp Psychol: Appl 2010;16:173–86.
[67] Huijts NMA, De Groot JIM, Molin EJE, Van Wee B. Intention to act towards a local hydrogen refueling facility: moral considerations versus self-interest. Transp Res Part A: Policy Pract 2013;48:63–74.
[68] Alhakami AS, Slovic P. A psychological study of the inverse relationship between perceived risk and perceived benefit. Risk Anal 1994;14:1085–96.
[69] Slovic P, Finucane ML, Peters E, MacGregor DG. The affect heuristic. Eur J Oper Res 2007;177:1333–52.
[70] Poortinga W, Pidgeon NF. Trust in risk regulation: cause or consequence of the acceptability of GM food? Risk Anal 2005;25:199–209.
[71] Rokeach M. The nature of human values. New York: The Free Press; 1973.
[72] Schwartz SH. Universals in the content and structures of values: theoretical advances and empirical tests in 20 countries. In: Zanna M, editor. Advances in experimental psychology, vol. 25. Orlando, FL: Academic Press; 1992. p. 1–65.
[73] Devine-Wright P. Place attachment and public acceptance of renewable energy: a tidal energy case study. J Environ Psychol 2011;31:336–43.
[74] Devine-Wright P, Howes Y. Disruption to place attachment and the protection of restorative environments: a wind energy case study. J Environ Psychol 2010;30:271–80.
[75] Vorkinn M, Riese H. Environmental concern in a local context: the significance of place attachment. Environ Behav 2001;33:249–63.
[76] Rousseau DM, Sitkin SB, Burt RS, Camerer C. Not so different after all: a cross-discipline view of trust. Acad Manag Rev 1998;23:393–404.
[77] Siegrist M. A causal model explaining the perception and acceptance of gene technology. J Appl Soc Psychol 1999;29:2093–106.
[78] Siegrist M. The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. Risk Anal 2000;20:195–204.
[79] Whitfield SC, Rosa EA, Dan A, Dietz T. The future of nuclear power: value orientations and risk perception. Risk Anal 2009;29:425–37.
[80] Siegrist M, Cvetkovich G. Perception of hazards: the role of social trust and knowledge. Risk Anal 2000;20:713–20.
[81] Montijn-Dorgelo FNH, Midden CJH. The role of negative associations and trust in risk perception of new hydrogen systems. J Risk Res 2008;11:659–71.
[82] Sjoberg L. Limits of knowledge and the limited importance of trust. Risk Anal 2001;21:189–98.
[83] Eiser JR, Miles S, Frewer LJ. Trust perceived risk, and attitudes toward food technologies. J Appl Soc Psychol 2002;32:2423–33.
[84] Earle TC, Siegrist M. Morality information, performance information, and the distinction between trust and confidence. J Appl Soc Psychol 2006;36:383–416.
[85] Terwel BW, Harinck F, Ellemers N, Daamen DDL. Competence-based and integrity-based trust as predictors of acceptance of carbon dioxide capture and storage (CCS). Risk Anal 2009;29:1129–40.
[86] Siegrist M, Cvetkovich G, Roth C. Salient value similarity, social trust, and risk/benefit perception. Risk Anal 2000;20:353–62.
[87] Maio GR. Mental representations of social values. In: Zanna MP, editor. Advances in experimental social psychology, vol. 42. San Diego, CA: Academic Press; 2010. p. 1–43.
[88] Rohan MJ. A rose by any name? The values construct Personal Soc Psychol Rev 2000;4:255–77.
[89] Schultz PW. The structure of environmental concern for self, other people, and the biosphere. J Environ Psychol 2001;21:327–39.
[90] Steg L, De Groot JIM, Dreijerink L, Abrahamse W, Siero F. General antecedents of personal norms, policy acceptability, and intentions: the role of values, worldviews, and environmental concern. Soc Nat Resour 2011;24:349–67.
[91] Bidwell D. The role of values in public beliefs and attitudes towards commercial wind energy. Energy Policy 2013;58:189–99.
[92] De Groot JIM, Steg L. Value orientations to explain beliefs related to environmental significant behavior: how to measure egoistic, altruistic, and biospheric value orientations. Environ Behav 2008;40:330–54.
[93] Dietz T, Fitzgerald A, Shwom R. Environmental values. Annu Rev Environ Resour 2005;30:335–72.
[94] Nordlund AM, Garvill J. Value structures behind proenvironmental behavior. Environ Behav 2002;34:740–56.
[95] Steg L, De Groot JIM. Environmental values. In: Clayton S, editor. The Oxford handbook of environmental and conservation psychology. New York: Oxford University Press; 2012.

[96] Stern PC. Toward a coherent theory of environmentally significant behavior. J Soc Issues 2000;56:407–24.
[97] Stern PC, Dietz T, Guagnano GA. A brief inventory of values. Educ Psychol Meas 1998;58:984–1001.
[98] Steg L, Perlaviciute G, Van der Werff E, Lurvink J. The significance of hedonic values for environmentally-relevant attitudes, preferences and actions. Environ Behav 2014;46:163–92.
[99] Dunlap RE, Van Liere KD, Mertig AG, Jones RE. New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale. J Soc Issues 2000;56:425–42.
[100] Spence A, Poortinga W, Pidgeon N, Lorenzoni I. Public perceptions of energy choices: the influence of beliefs about climate change and the environment. Energy Environ 2010;21:385–407.
[101] Bang HK, Ellinger AE, Hadjimarcou J, Traichal PA. Consumer concern, knowledge, belief, and attitude toward renewable energy: an application of the reasoned action theory. PsycholMark 2000;17:449–68.
[102] Von Borgstede C, Andersson M, Johnsson F. Public attitudes to climate change and carbon mitigation—implications for energy-associated behaviours. Energy Policy 2013;57:182–93.
[103] Bohm G, Pfister HR. Action tendencies and characteristics of environmental risks. Acta Psychol 2000;104:317–37.
[104] Gardner GT, Stern PC. Environmental problems and human behaviour. 2nd ed. Boston, MA: Pearson Custom Publishing; 2002.
[105] Bardi A, Goodwin R. The dual route to value change: individual processes and cultural moderators. J Cross-Cult Psychol 2011;42:271–87.
[106] Lonnqvist JE, Jasinskaja-Lahti I, Verkasalo M. Personal values before and after migration: a longitudinal case study on value change in Ingrian–Finnish migrants. Soc Psychol Personal Sci 2011;2:584–91.
[107] Bolderdijk JW, Steg L, Geller ES, Lehman PK, Postmes T. Comparing the effectiveness of monetary versus moral motives in environmental campaigning. Nat Clim Change 2013;3:413–6.
[108] Thøgersen J. Inducing green behaviour. Nat Clim Change 2013;3:100.
[109] Abrahamse W, Steg L, Vlek C, Rothengatter T. The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. J Environ Psychol 2007;27:265–76.
[110] Kunda Z. Social cognition: making sense of people. Cambridge, MA: MIT Press; 1999.
[111] Lord CG, Ross L, Lepper MR. Biased assimilation and attitude polarization: the effects of prior theories on subsequently considered evidence. J Personal Soc Psychol 1979;37:2098–109.
[112] M. Keizer, L. Steg and M. Van Zomeren. The influence of normative considerations on use of renewable energy sources by households in six European countries. In preparation.
[113] Terwel BW, Harinck F, Ellemers N, Daamen DDL. How organizational motives and communications affect public trust in organizations: the case of carbon dioxide capture and storage. J Environ Psychol 2009;29:290–9.
[114] Lindenberg S, Steg L. What makes organisations in market democracies adopt environmentally-friendly policies? In: Huffman AH, Klein SR, editors. Green organizations: driving change with I-O psychology. New York, NY: Routledge; 2013.
[115] Verplanken B, Holland RW. Motivated decision making: effects of activation and self-centrality of values on choices and behavior. J Personal Soc Psychol 2002;82:434–47.
[116] Maio GR, Olson JM, Allen L, Bernard MM. Addressing discrepancies between values and behavior: the motivating effect of reasons. J Exp Soc Psychol 2001;37:104–17.
[117] Keizer K, Lindenberg S, Steg L. The spreading of disorder. Science 2008;322:1681–5.
[118] Keizer K, Lindenberg S, Steg L. The importance of demonstratively restoring order. PLoS ONE 2013;8(6):e65137, http://dx.doi.org/10.1371/journal.pone.0065137.
[119] Evans L, Maio GR, Corner A, Hodgetts CJ, Ahmed S, Hahn U. Self-interest and pro-environmental behaviour. Nat Clim Change 2012;3:122–5.
[120] Steg L, De Groot JI, Dreijerink L, Abrahamse W, Siero F. General antecedents of personal norms, policy acceptability, and intentions: the role of values, worldviews, and environmental concern. Soc Nat Resour 2011;24:349–67.